APPENDIX I
ATTACHMENT 1: INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT'S 2012 CONSOLIDATED ASSESSMENT AND LISTING METHODOLOGY (REVISED)

REGULATORY BACKGROUND

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's water quality standards (WQS) for designated uses. For these impaired waters, states are required to establish total maximum daily loads (TMDLs) to meet the state WQS. In addition, the U.S. EPA has released guidance recommending that states, territories, and authorized tribes submit an Integrated Water Quality Monitoring and Assessment Report (IR) that will satisfy CWA requirements for both the Section 305(b) water quality report and Section 303(d) list of impaired waters. Indiana Department of Environmental Management (IDEM) has integrated this guidance into its Consolidated Assessment and Listing Methodology (CALM).

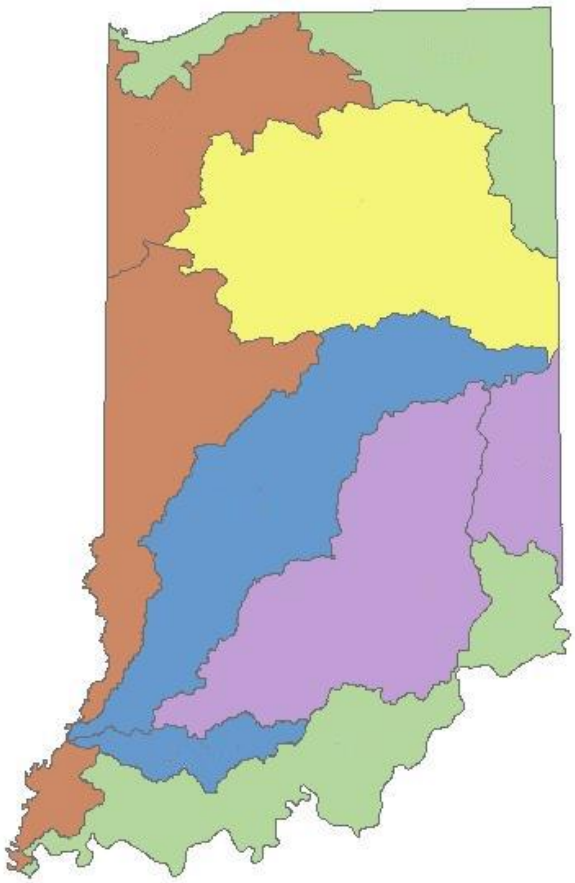
IDEM'S SURFACE WATER QUALITY MONITORING STRATEGY

IDEM has developed a water quality monitoring strategy (WQMS) to guide its monitoring activities which are aimed at assessing the quality of Indiana's surface waters. Specific goals of the WQMS include:

- Measure the physical, chemical, bacteriological, and biological quality of the aquatic environment in all river basins and identify factors responsible for impairment.
- Assess the impact of human and other activities on the surface water resource.
- Identify trends through the analysis of environmental data, and
- Provide environmental quality assessment to support water quality management programs.

To achieve these goals, IDEM has divided the state into five major water management basins. The WQMS describes a rotating basin approach that allows IDEM to focus its monitoring resources in a different basin each year. IDEM's 305(b) assessment and 303(d) listing processes also follow the rotating basin. With this approach, Indiana's rivers and streams in each major basin are monitored and assessed every five years (Figure 1). Lakes and reservoirs in Indiana are monitored for IDEM by the Indiana Clean Lakes Program (CLP) administered by Indiana University's School of Public and Environmental Affairs. This monitoring does not follow the rotating basin due to the unequal distribution of lakes across the Indiana landscape. Using an approach similar to rotating basins, lakes throughout the state are divided into five regions which are defined in a way that maximizes monitoring resources. The following monitoring programs provide water quality data in support of IDEM's CWA programs:

- Watershed Monitoring Program
- Fixed Station Monitoring Program
- *E. coli* Monitoring Program
- Fish Community Monitoring Program
- Fish Tissue Contaminant Monitoring Program
- Macroinvertebrate Community Monitoring Program
- Special Projects
- Clean Lakes Program



White River, East Fork and
Whitewater River Basins
Monitoring: 2002
Assessment: 2003/2004
Integrated Report: 2006
303(d) List: 2006

Upper Wabash River Basin
Monitoring: 2003
Assessment: 2004/2005
Integrated Report: 2006
303(d) List: 2006

Lower Wabash River and
Kankakee River Basins
Monitoring: 2004
Assessment: 2005/2006
Integrated Report: 2008
303(d) List: 2008

Great Lakes and
Ohio River Basins
Monitoring: 2005
Assessment: 2006/2007
Integrated Report: 2008
303(d) List: 2008

White River, West Fork
and Patoka River Basins
Monitoring: 2006
Assessment: 2007/2008
Integrated Report: 2010
303(d) List: 2010

Figure 1: The five major water management basins in Indiana as defined by IDEM to support the Agency's rotating basin monitoring, assessment, reporting and listing schedule.

DESIGNATED USES

The CWA provides the underpinning for Indiana's WQS (327 IAC Article 2), which are designed to ensure that all waters of the state, unless specifically exempted, are safe for full body contact recreation and are protective of aquatic life, wildlife, and human health. These beneficial uses are described in the state's WQS as "designated" uses. IDEM monitors and assesses Indiana's surface waters to determine the extent to which they meet WQS; and thus support their designated uses and to identify where possible the sources of impairment for those waters that do not support one or more of these uses.

WATER QUALITY ASSESSMENT METHODOLOGY

Use Support status is determined for each waterbody using the assessment guidelines provided in the U.S. EPA documents *Guidelines for Preparation of the State Water Quality Assessments (305[b] Reports) and Electronic Updates: Report Contents* (EPA-841-B-97-002A), *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* (U.S. EPA, 2005), and the additional guidance provided in the U.S. EPA memorandum *Information Concerning 2010 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions* (U.S. EPA, 2009). Available results from six types of monitoring data listed below are integrated to provide an assessment for each stream waterbody for 305(b) reporting and 303(d) listing purposes:

- Physical or chemical water results
- Fish community assessment
- Benthic aquatic macroinvertebrate community assessments
- Fish tissue and surficial aquatic sediment contaminant results
- Habitat evaluation
- *E. coli* monitoring results

WATERBODY ASSESSMENT UNITS AND THE ASSESSMENT DATABASE

IDEM maintains its CWA Section 305(b) assessment and 303(d) listing information in the Assessment Database ADB). Each waterbody assessment unit (AU) is assigned a unique identifier in the ADB to which all assessment information for that waterbody is associated. This identifier is called an assessment unit ID (AUID).

In general, each AUID corresponds to the watershed in which it is located as defined by the United State Geological Survey (USGS) hydrologic unit code (HUC) system, which is a hierarchical system that divides and then subdivides the United States successively smaller geographic areas based on surface hydrologic features, or drainages. Under this system, the average size of an 8-digit hydrologic unit area in Indiana, commonly known as a subbasin, is about 448,000 acres (700 square miles). The 12- and 14-digit hydrologic unit areas, or subwatersheds, within an 8-digit hydrologic unit area are much smaller. The 12- and 14-digit hydrologic unit areas in Indiana range in size from less than five acres (less than one square mile) to about 28,000 acres (almost 44 square miles).

WATERBODY ASSESSMENT UNITS AND IDEM'S REACH INDEX

The geographical extent and location of each AU within a given 12- or 14-digit HUC are defined

for mapping purposes through a process called reach indexing. Reach indexing uses a software tool developed by U.S. EPA that works with geographical information systems (GIS) applications to delineate for a waterbody one or more units of assessment and to "key" these AU (as defined by IDEM) to the National Hydrography Dataset (NHD)[1]. This "key" is called the Reach Index. IDEM used these tools to create its first statewide Reach Index in 2002, which facilitates mapping of Indiana's 305(b) assessments and 303(d) listings in GIS applications and incorporation of this information into IDEM's ADB and U.S. EPA's national databases.

In these databases, Indiana lakes and reservoirs, including Lake Michigan, are assigned a single AUID with sizes reported in acres. Indiana's Lake Michigan shoreline is divided and assigned AUIDs in accordance with the 8-digit HUC in which they are located and are reported in miles. Rivers and streams are assigned AUIDs in accordance with the 12- or 14-digit HUC in which they are located and are reported in miles. For large rivers with more than 1,000 square miles of drainage area, the AUIDs for mainstem nonwadeable reaches within their 12-14 digit HUCs are distinguished from those smaller, wadeable streams so that issues such as sampling techniques, which might bias results, can be considered within a class of streams. With regard to Indiana's flowing waters, AU sizes vary widely and a single segment may or may not represent the entire river or stream to which it is associated.

Revisions to IDEM's Reach Index

In 2006, IDEM developed an administrative process for splitting AUs into smaller units to allow for more accurate application of assessment data. When Indiana created its Reach Index, most waterbodies in the state were assigned an AUID based on the 14-digit watershed in which they were located. In most cases, each 14-digit watershed was assigned a single AUID regardless of how many individual streams were located in the watershed. Therefore, an assessment of *any* stream would be applied to *all* the streams in the watershed regardless of where the sample was located or its relative representativeness to each stream. This problem was not preventable at the time because, while the reach indexing tool had the capability to split "watershed" AUs into smaller AUs, the software had no built-in means for tracking changes in segmentation.

Changes in segmentation were considered on a case-by-case basis and were generally made either to accommodate a more accurate assessment or to correct an earlier assessment in which the data were inappropriately applied. When AUs were split, IDEM reevaluated previous assessments of the original AU along with any recent data that were available at the time of resegmentation. This reassessment process ensured that the original assessment information was properly applied to the resulting new AUs. In most cases, the original assessment was applied to only one or two of the resulting AUs with the remaining units unassessed. IDEM continued using resegmentation through the 2008 cycle to more accurately apply assessment data. However, when the NHD became available for the entire state at the high resolution, it was found that a significantly higher number of first and second order streams[2] appear at the 1:24,000 scale than IDEM's 1:100,000 scale Reach Index contained. These small streams and stream networks are an important component of the hydrology in their watersheds and can have significant effects on water quality in larger streams. Given this, IDEM decided that revising the Reach Index as a whole at 1:24,000 scale instead of continuing with resegementation on a case-by-case basis at 1:100,000 scale would do the following:

[1] The NHD is a database created by U.S. EPA and the USGS that provides a comprehensive coverage of hydrographic data for the United States. It uniquely identifies and interconnects the stream segments that comprise the nation's surface water drainage system and contains information for other common surface waterbodies such as lakes, reservoirs, estuaries, and coastlines.

[2] Stream order is a measure of the relative size of streams. Streams sizes range from the smallest "first-order" stream (for example, a small creek) to the largest or "twelfth-order" stream (for example, the Amazon River).

- Reduce the effort required to track segmentation changes, and;
- Result in a statewide reach index with AUs that allow more thorough and representative water quality assessments

This decision to revise the Reach Index using the high resolution NHD better supports IDEM's 305(b) assessment and 303(d) listing processes and TMDL development than resegmentation on a case-by-case basis. However, it requires significant staff resources. Given this, in 2009, IDEM decided to implement a "moratorium" on segmentation changes for the 2010 assessment and listing cycle and to reallocate staff resources to the work of Reach Indexing at high resolution instead. Resegmentations are now done on a very limited basis when needed to support NPDES permit development or other OWQ program needs.

At this time, it is anticipated that IDEM will complete its high resolution Reach Index prior to the 2012 integrated report cycle. In the meantime, IDEM has prioritized its high resolution indexing work to stay ahead of TMDL development, focusing indexing efforts in those watersheds (at the 8-digit hydrologic unit, or HUC scale) in which one or more TMDLs will be developed for the next 303(d) listing cycle. Once Indiana's high resolution reach index is completed, the need to split segments using the segmentation process will be virtually eliminated.

Similar to IDEM's original resegmentation process, the high resolution indexing process also involves splitting the original AU into smaller more representative units considering a combination of factors including hydrology, similarities in land use and potential sources of impairment. However, IDEM's high resolution indexing process defines new AU based on small catchment basins (very small watersheds) and then adds the new streams that appear on the map at the 1:24,000 scale NHD to these new AU.

The result is a far more accurate representation of Indiana's hydrology and AU that are more homogeneous and thus more representative for the purposes of water quality assessment and TMDL development. For the 2010 cycle, IDEM also began incorporating the new USGS 12-digit hydrologic units into the indexing process to better support the Nonpoint Source Section 319 program, which has adopted this scale for watershed management planning and implementation purposes.

Any change in segmentation, whether from resegmentation done on a case-by-case basis or for the purposes of incorporating high resolution NHD data, must be accurately tracked so that 305(b) assessment and 303(d) listing information associated with the original AU is not lost. To this end, IDEM's has refined its original methods developed to track segmentation changes to track changes now being made to the Reach Index as a result of high resolution indexing. As before, per U.S. EPA's request, IDEM still retires the original AUID for any AU that has been reindexed. And, IDEM also uses the same reassessment process to evaluate existing assessments and listing information on each AU reindexed to ensure that no valuable information is lost and that assessment information is appropriately applied to the new AU resulting from the reindexing effort.

IDEM's Process for Indexing at High Resolution Using a Catchment Basin Approach

The goal of the high resolution indexing process is to identify all streams and stream reaches that are representative for the purposes of assessment. In practice, this process leads to grouping tributary streams into smaller catchment basins of similar hydrology, land use, and other characteristics such that all tributaries within the catchment basin can be expected to have similar potential impacts. Catchment basins, as defined by the aforementioned factors are typically very small, which significantly reduces the variability in the water quality we might expect from one stream or stream reach to another. Given this, all tributaries within a catchment basin are assigned a single AUID. Grouping tributary systems into smaller catchment basins also allows for better characterization of the larger watershed. Variability

within the larger watershed will be accounted for by the differing AUIDs assigned to the different catchment basins.

Using the catchment basin approach, indexing at high resolution is guided in large part by the hydrology of a system. This is because the mechanisms of large streams and river are very different from those of small streams and tributary system, making it logical to separate these into separate AUIDs. However, other factors are also considered when deciding how to define a water quality AU:

- Varying land uses within a watershed are also considered because rural development is expected to have different impacts on a stream than urban areas, which in turn, have different impacts to a stream segment than forested areas.
- The presence and locations of any permitted facilities are considered due to their potential impact on the hydrology of a given stream and their potential to impact water quality, depending on the type of facility and whether the facility is operating efficiently.
- Any other known factors that might reasonably be expected to impact hydrology or water quality, or both (for example, dams, channelization, wetlands, etcetera.).

Aerial photography is particularly important in determining appropriate segmentation within a watershed because it provides very recent and accurate information about the presence and thickness of riparian buffers, the presence and spatial extent of rural development, and the types of land use practices in the watershed, all of which help to determine where we might expect to see differences in water quality resulting from one or more of these factors. Due to the potential impacts these factors can have on stream water quality, they are all considered when determining whether segmentation should occur and where it should occur along the stream reach.

The Reassessment Process associated with Reach Indexing

On each AU indexed, IDEM conducts a reassessment to evaluate any existing information in the ADB for all designated uses assessed to ensure that no valuable information is lost and that assessment information is appropriately applied to the resulting new AU.

Because IDEM prioritizes its high resolution indexing based on TMDL development, the reassessments conducted for the purposes of TMDL development consider only those designated use impairments for which the TMDL is being developed. However, IDEM's reassessment must also consider any existing information in the ADB associated with other designated uses that are not considered in the TMDL.

This process is particularly complicated in cases where there are two or more previously assessed AU that were combined through the indexing process. For each new AU to be entered into the ADB, report(s) must be generated from the database for the original AU(s) from which the new AU was derived. These reports must then be compared to determine, for each designated use, whether there is any existing assessment information for the original AU(s) and to identify any conflicting assessment information. Any conflicting information must be resolved prior to entering the new AU into the ADB. This requires a reevaluation of all the data used to make the use assessments on the original AU to determine which, if any are applicable to the new AU.

The reassessment process is conducted as time allows, preferably prior to entering the data into the ADB. However, if the reassessment cannot be accomplished prior to ADB data entry, all information from the original AU(s) is carried over and any conflicting assessment information is noted for later resolution ensuring that no valuable assessment information is lost.

WATER QUALITY ASSESSMENT DECISIONS

The designated uses outlined in Indiana's WQS and the narrative and numeric criteria to protect them provide the underpinning for IDEM's 305(b) assessment process and 303(d) listing decisions.Water quality assessments are made by compiling existing and readily available data from site-specific chemical (water, sediment, and fish tissue), physical (habitat, flow data), and biological (fish community, macroinvertebrates, and *E. coli*) monitoring of Indiana's rivers, streams, and lakes and evaluating those data against Indiana's WQS. Waters identified as not meeting one or more of their designated uses are then placed on the Indiana's 303(d) List of Impaired waters. IDEM's decision-making criteria are a combination of the narrative and numeric criteria expressed in Indiana's WQS in IAC 327, Article 2. More detailed information regarding IDEM's WQS-based approach to evaluating fish tissue data and IDEM's use of site-specific water quality criteria in the 305(b) assessment process is also provided.

Chemical data for toxicants [dissolved metals, polynuclear aromatic hydrocarbons (PAHs), pesticides, ammonia, and free cyanide], conventional water chemistry parameters (dissolved oxygen, pH, temperature, and anions), and bacteria (*E. coli*) were evaluated for compliance with Indiana's WQS (327 IAC 2-1-6 and 327 IAC 2-1.5-8). U.S. EPA 305(b) guidelines were applied to chemical and biological data as indicated in Guidelines for Preparation of the State Water Quality Assessments (305[b] Reports) and Electronic Updates: Supplement (EPA-841-B-97-002B).

Table 1 shows the minimum data required for 305(b) assessments. For each AU with sufficient data to make one or more designated use assessments, IDEM applies the 305(b) assessment process described in Table 2. Assessment data are integrated for the purposes of making water quality assessments, meaning that all data for a given waterbody are considered together. In accordance with U.S. EPA policy, IDEM generally treats each type of data as independently applicable.

Table 1: Minimum data requirements for CWA 305(b) assessments.

Parameter Type	Minimum Information Required for Assessment
Aquatic Life Use Support – Rivers and Streams	
Toxicants	Minimum of three measurements
Conventional Inorganics	Minimum of three measurements
Nutrient Parameters	Minimum of three measurements and two or more of parameters must have been exceeded on same date in order to classify a waterbody as impaired.
Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI)	Minimum of one measurement, preferably with corresponding qualitative habitat use evaluation (QHEI) score*
Fish community (IBI)	Minimum of one measurement, preferably with corresponding qualitative habitat use evaluation (QHEI) score*
*The Qualitative Habitat Evaluation Index (QHEI) is not required to determine aquatic life use support but is used, when available in conjunction with macroinvertebrate community scores (mIBI) or fish community scores (IBI) or both to evaluate the role that habitat plays in waterbodies where impaired biotic communities (IBC) have been identified.	
Aquatic Life Use Support – Lakes and Reservoirs	
Indiana Dept. of Natural Resources (IDNR) surveys of the status of sport fish communities in lakes	No minimum sample requirement; Assessments are revised with most recent plans published by IDNR.
IDNR Trout Stocking Plans	No minimum sample requirement; Assessments are revised with most recent plans published by IDNR.
IDNR information on pH levels in lakes and reservoirs	No minimum sample requirement; Assessments based on narrative reports and communication from IDNR staff.
Temperature	No minimum sample requirement; Assessments for lake temperatures are not a regular part of IDEM's assessment process. All data are reviewed when readily available and adequacy of the data set as a whole is determined on a case-by-case basis.
Fish Consumption Use Support (Human Health)	
PCBs in Fish Tissue	One actual concentration value for the site for a single species and size class
Mercury in Fish Tissue	One trophic level weighted arithmetic mean concentration value calculated on all samples from the site from a single sampling event
Recreational Use Support (Human Health) – All waters	
Bacteria (*E. coli*)	Minimum of ten grab samples or one geometric mean result calculated from five equally spaced samples over thirty days.
Recreational Use Support (Aesthetics) – Lakes and Reservoirs	
Natural Lakes and Reservoirs	Minimum of three total phosphorus results with corresponding Chlorophyll a results collected over three years (consecutive or nonconsecutive).
Drinking Water Use Support – Rivers and Streams	
Toxicants	Minimum of three measurements
Conventional Inorganics	Minimum of three measurements

Parameter Type	Minimum Information Required for Assessment
Taste and odor producing substances	No minimum sample requirement; Weight of evidence approach is used; typically requires numerous public complaints regarding taste and odor such that water utility must employ additional treatment to remedy the problem.
Drinking Water Use Support – Lakes and Reservoirs	
Applications for permits to apply algaecides	One permit application

Table 2: Water quality assessment methodology for determining designated use support for all waters except the Ohio River.

Aquatic Life Use Support - Rivers and Streams		
Toxicants	Dissolved metals, pesticides, polyaromatic hydrocarbons (PAH), free cyanide, ammonia were evaluated on a site-by-site basis and judged according to the magnitude of the exceedance(s) of Indiana's WQS and the number of times the exceedance(s) occurred. For any one pollutant (grab or composite samples), the following assessment criteria are applied to data sets consisting of three or more measurements.	
	Fully Supporting	**Not Supporting**
	≤1 exceedance of the acute criteria within a three-year period, and ≤1 exceedance of the chronic criteria for aquatic life within a three-year period.	>1 exceedance of the acute or chronic criteria for aquatic life within a three-year period.
Conventional inorganics	Dissolved oxygen, pH, sulfates, chlorides were evaluated for the exceedance(s) of Indiana's WQS. For any one pollutant, the following assessment criteria are applied to data sets consisting of three or more measurements.	
	Fully Supporting	**Not Supporting**
	For dissolved oxygen, one or more samples may be <4mg/L, but no more than 10% of all measurements are <5mg/L. For other conventional inorganics, criteria are exceeded in ≤10% of measurements.	For dissolved oxygen, one or more samples <4mg/L and more than 10% of all measurements are <5mg/L. For other conventional inorganics, criteria are exceeded in >10% of measurements.

<table>
<tr><td>Nutrients</td><td colspan="2">Nutrient conditions were evaluated on a site by site basis using the benchmarks described below. In most cases, two or more of these conditions must be met on the same date in order to classify a waterbody as impaired. This methodology assumes a minimum of three sampling events.
Total Phosphorus: One or more measurements >0.3 mg/L
Nitrogen (measured as NO_3 + NO_2) – One or more measurements >10.0 mg/L
Dissolved Oxygen (DO) -- Measurements below the water quality standard of 4.0 mg/l or measurements that are consistently at/close to the standard, in the range of 4.0-5.0 mg/L or values >12.0 mg/L
pH measurements -- Measurements above the water quality standard of 9.0 or measurements that are consistently at/close to the standard, in the range of 8.7- 9.0
Algal Conditions -- Algae are described as “excessive” based on field observations by IDEM scientists.</td></tr>
<tr><td rowspan="2">Benthic aquatic macroinvertebrate Index of Biotic Integrity (mIBI) Scores (Range of possible scores is 12-60)</td><td>Fully Supporting</td><td>Not Supporting</td></tr>
<tr><td>mIBI >36</td><td>mIBI <36</td></tr>
<tr><td>Fish community (IBI) Scores (Range of possible scores is 6-60)</td><td>IBI ≥36</td><td>IBI <36</td></tr>
<tr><td>Qualitative habitat use evaluation (QHEI) (Range of possible scores is 0-100)</td><td colspan="2">The Qualitative Habitat Evaluation Index (QHEI) is not used to determine aquatic life use support. Rather, the QHEI is an index designed to evaluate the lotic habitat quality important to aquatic communities and is used in conjunction with mIBI or IBI data, or both to evaluate the role that habitat plays in waterbodies where impaired biotic communities (IBC) have been identified. QHEI scores are calculated using six metrics: substrate, instream cover, channel morphology, riparian zone, pool/riffle quality, and gradient. A higher QHEI score represents a more diverse habitat for colonization of aquatic organisms. IDEM has determined that a QHEI total score of <51 indicates poor habitat. For streams where the macroinvertebrate community (mIBI or mHab) or fish community (IBI) scores indicate IBC, QHEI scores are evaluated to determine if habitat is the primary stressor on the aquatic communities or if there may be other stressors/pollutants causing the IBC.</td></tr>
<tr><td colspan="3">Aquatic Life Use Support – Lakes and Reservoirs</td></tr>
<tr><td rowspan="2">Indiana Department of Natural Resources surveys of the status of sport fish communities in lakes and information on trout stocking.</td><td>Fully Supporting</td><td>Not Supporting</td></tr>
<tr><td>Supports cold water fishery, including native Cisco and stocked trout, or both.</td><td>Native Cisco population is gone or lake unable to support stocked trout and lake attributes, or both, appear to contribute to warm water fishery condition.</td></tr>
<tr><td>Temperature and pH</td><td colspan="2">Lakes in which thermal modifications have caused an adverse effect on aquatic life and lakes that do not meet Indiana’s WQS for pH have been assessed as not supporting of aquatic life use.</td></tr>
</table>

Fish Consumption Use Support (Human Health)		
Available fish tissue data for the most recent twelve years of data collection are evaluated. Only waters for which sufficient fish tissue data were available were assessed for fish consumption All results from sampling locations considered representative of a given assessment unit (lake or reservoir; stream or stream reach) must be below the benchmarks for mercury and PCBs in order to be assessed as fully supporting. For PCBs, all waters with a single sample result for a given species exceeding the applicable benchmark are classified as impaired. For mercury, all waters with a trophic level weighted arithmetic mean result (calculated with all the samples collected during the same sampling event) that exceeds the applicable benchmark are classified as impaired.		
Mercury in Fish Tissue	**Fully Supporting**	**Not Supporting**
	Trophic level weighted arithmetic mean concentration values for all sampling events are ≤0.3 mg/kg wet weight	Trophic level weighted arithmetic mean concentration values for one or more sampling events are >0.3 mg/kg wet weight
PCBs in Fish Tissue	**Fully Supporting**	**Not Supporting**
	Actual concentration values for all samples are ≤0.02 mg/kg wet weight	Actual concentration values for one/more samples are >0.02 mg/kg wet weight

Recreational Use Support (Human Health) – All waters		
IDEM has two different criteria for recreational use assessments depending on the type of data set being used in making the assessment. For data sets consisting of five equally spaced samples over a 30-day period, we apply two tests, both of which are based on U.S. EPA's Ambient Water Quality Criteria for Bacteria - 1986 (EPA440/5-84-002), which provides the foundation for Indiana's WQS for recreational use. For data sets consisting of 10 or more grab samples where no five of which are equally spaced over a 30-day period, the 10% rule is applied. Specific criteria are provided below.		
	Fully Supporting	**Not Supporting**
Bacteria (*E. coli*): at least five equally spaced samples over 30 days. (cfu = colony forming units)	Geometric mean does not exceed 125 cfu/100mL And No more than one sample is >576 cfu/100mL (for waters infrequently used for full body contact) or 235 cfu/100mL (for bathing beaches)[3].	Geometric mean exceeds 125 cfu/100mL.
Bacteria (*E. coli*): grab samples (cfu = colony forming units)	No more than 10% of measurements are >576 cfu/100ml (for waters infrequently used for full body contact) or 235 cfu/100mL (for bathing beaches). And No more than one sample is >2,400 cfu/100mL.	More than 10% of samples are >576 cfu/100mL or more than one sample is >2,400 cfu/100mL.

[3] The value of 576 cfu/100mL comes from U.S. EPA's Ambient Water Quality Criteria for Bacteria - 1986 (EPA440/5-84-002) and represents the single sample maximum applicable to waters infrequently used for full body recreation. For data collected from bathing beaches, the single day maximum value of 235 cfu/100mL is applied.

<table>
<tr><th colspan="3">Drinking Water Use Support – Rivers and Streams</th></tr>
<tr><td colspan="3">Rivers are designated for drinking water uses if a community water supply has a drinking water intake somewhere along the segment. When IDEM has data for a segment with a drinking water intake, those data are compared to the applicable ambient water quality criteria in Indiana's WQS to determine if the drinking water use is met. The appropriate water quality criteria are applied for specific substances identified in the WQS. Information regarding non-naturally occurring taste and odor producing substances not specifically identified in the WQS are reviewed within the context of a water treatment facility's ability to meet Indiana's drinking WQS using conventional treatment.</td></tr>
<tr><td>Toxicants</td><td colspan="2">Dissolved metals, pesticides, PCBs, free cyanide were evaluated on a site by site basis and judged according to magnitude of the exceedance(s) of Indiana's WQS for point of water intake and the number of times exceedance(s) occurred. For any one pollutant (grab or composite samples), the following assessment criteria are applied.</td></tr>
<tr><td rowspan="2"></td><th>Fully Supporting</th><th>Not Supporting</th></tr>
<tr><td>No more than one exceedance of the acute or chronic criteria for human health within a three-year period.</td><td>More than one exceedance of the acute or chronic criteria for human health within a three-year period.</td></tr>
<tr><td rowspan="3">Conventional inorganics</td><td colspan="2">Total dissolved solids, specific conductance, sulfate, chloride, nitrite-N and nitrogen (measured as $NO_3 + NO_2$) were evaluated for the exceedance(s) of Indiana's WQS for point of water intake and the number of times the exceedance(s) occurred. For any single pollutant (grab or composite samples), the following assessment criteria are applied to data sets consisting of three or more measurements.</td></tr>
<tr><th>Fully Supporting</th><th>Not Supporting</th></tr>
<tr><td>No more than one exceedance of the acute or chronic criteria for human health within a three-year period.</td><td>More than one exceedance of the acute or chronic criteria for human health within a three-year period.</td></tr>
<tr><td rowspan="2">Taste and odor producing substances</td><th>Fully Supporting</th><th>Not Supporting</th></tr>
<tr><td>Taste and odor substances not present in quantities sufficient to interfere with production of drinking water by conventional treatment</td><td>Taste and odor substances present in quantities requiring additional treatment by the public water supply to prevent taste and odor problems</td></tr>
</table>

Recreational Use Support (Aesthetics) – Lakes and Reservoirs		
	Fully Supporting	**Not Supporting**
Natural Lakes	No more than 10% of all TP values >54 ug/L and their associated Chla values are <20ug/L	Less than 10% of all TP values are >54 ug/L but their associated Chla values are >20ug/L, and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values <4ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values >4ug/L
	Fully Supporting	**Not Supporting**
Reservoirs	No more than 10% of all TP values >51 ug/L and their associated Chla values are <25ug/L	Less than 10% of all TP values are >51 ug/L but their associated Chla values are >25 ug/L and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values <2ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values >2ug/L
Drinking Water Use Support – Lakes and Reservoirs		
Information on the application of pesticides to surface drinking water reservoirs	Reservoirs or lakes that serve as source water for public water supplies that received pesticide (algaecide) application permits for algae were classified as not supporting because additional treatment by the public water supply was required to prevent taste and odor problems.	
Other Assessments – Lakes and Reservoirs		
Indiana Trophic State Index (TSI)	Nutrients, ammonia, dissolved oxygen, light transmission and light penetration in the water column turbidity, and algae growth were used to determine TSI scores. Trophic scores were used to classify lakes according to their trophic state. Lake trends were also assessed for lakes with two or more trophic scores if at least one of the scores was less than five years old. Trophic scores and lake trends are not used to determine use support status. These assessments are conducted to fulfill Clean Water Act Section 314 reporting requirements for publicly owned lakes and reservoirs.	

IDEM's Use of Site-Specific Criteria

Indiana's WQS contain provisions for the calculation of site-specific criteria (SSC) for the protection of aquatic life and human health in order to provide 1) an additional level of protection, or 2) a less stringent criteria in cases where it can be shown that site-specific conditions indicate the criterion contained in Indiana's WQS for the pollutant in question is unnecessarily stringent[4]. SSC are typically developed for the NPDES program on a case-by-case basis to ensure that the specific pollutant(s) contained in a permitted discharge do not impair aquatic life or human health use support.

The SSC expressed in Indiana's WQS apply only to the stream or stream reach and the pollutant for which they were calculated. Until now, IDEM has been generally unable to apply SSC in its assessment processes because of the way AU are defined. Few SSC are broadly applicable to the basin in which they are located. Therefore, in order to apply SSC, the AU must match the reach to which the criterion applies both in terms of its location and length. In most cases, the AU as a whole is larger than the reach to which the SSC applies. Given this, applying a SSC to the entire AU would result in the criterion being used to assess the water quality condition for the entire waterbody as opposed to the specific reach to which it applies. In the past, IDEM's policy in these cases has been to give precedence to the ambient water quality criterion expressed in the state's WQS.

IDEM has put the necessary internal processes in place to conduct the resegmentations that are needed to more accurately apply SSC. Such resegmentations require close coordination between IDEM's NPDES, Water Quality Standards, and 305(b)/303(d) programs. Given the scientific and regulatory complexities involved, these resegmentations are rare and must necessarily be considered on a case-by-case basis. In the future, IDEM plans to coordinate this work with NPDES permit renewals for those facilities discharging to waters with applicable SSC.

OHIO RIVER ASSESSMENTS

IDEM collaborates with the Ohio River Valley Water Sanitation Commission (ORSANCO) to conduct water quality assessments of the Ohio River reaches that border Indiana. ORSANCO is an interstate water pollution control agency for the Ohio River established through a compact agreement between member states and approved by Congress. Under the terms of the compact, member states cooperate in the control of water pollution in the Ohio River Basin.

ORSANCO monitors the Ohio River on behalf of the compact states under CWA Section 305(b) and produces a water quality assessment report of its water quality condition every two years. Although this report identifies water quality issues on the Ohio River, unlike its compact states, ORSANCO is not required to develop a 303(d) List of Impaired Waters. Identifying Ohio River impairments on a 303(d) list for the purposes of TMDL development is the responsibility of each compact state.

Development of Assessment Methodologies for the Ohio River

Every two years, ORSANCO prepares a description of the proposed assessment methodology for review by the 305(b) workgroup, which is made up of state agency personnel responsible for preparing the Integrated Reports in each state and one or more U.S. EPA representatives responsible for reviewing state reports. When the 305(b) Work Group reaches agreement on the methodology, it is submitted to ORSANCO's Technical Committee for review and approval. Once approved, ORSANCO applies the methodology to the available information to make its preliminary assessments, which are then distributed to the 305(b) Work Group for review. When the 305(b) Work Group reaches agreement on

[4] The procedures used to calculate SSC are provided in 327 IAC 2-1.5-16 for waters within the Great Lakes Basin and 327 IAC 2-1-8.9 for downstate waters.

the assessment, each state incorporates the results into its Integrated Report and 303(d) List of Impaired Waters, and ORSANCO completes its 305(b) report for submission to U.S. EPA.

ORSANCO's role in completing Ohio River use attainment assessments and developing a biennial report on Ohio River water quality conditions is primarily to facilitate interstate consistency in CWA 305(b) assessments and how impairments are identified on states' 303(d) lists for the purposes of TMDL development. However, such consistency is not always possible given the differences in states' WQS and their CWA Sections 305(b) and 303(d) assessment and listing methodologies. Given these differences, member states are not obligated to incorporate any or all of ORSANCO's water quality assessments into their own reports. Specifically, U. S. EPA guidance states that "data and information in an interstate commission 305(b) report should be considered by the states as one source of readily available data and information when they prepare their Integrated Report and make decisions on segments to be placed in Category 5; however, data in a 305(b) Interstate Commission Report should not be automatically entered in a state Integrated Report or 303(d) list without consideration by the state about whether such inclusion is appropriate." (U.S. EPA, 2005)

Appendix A contains a comparison of the relative stringencies of applicable criteria in ORSANCO's Pollution Control Standards (PCS) and Indiana's WQS and the different ways in which these criteria are used to determine the degree to which the Ohio River supports aquatic life use, recreational use, and fish consumption.

In order to achieve consistency with other member states, IDEM generally defers to ORSANCO's methods for evaluating the available data for assessment purposes. And, where there are no significant differences between ORSANCO's criteria and those expressed in Indiana's WQS, IDEM incorporates ORSANCO's assessments directly into its Integrated Report and 303(d) List applying them to the corresponding reaches defined in IDEM's ADB. However, in cases where the water quality criteria ORSANCO use are less stringent than the water quality criteria expressed in Indiana's WQS and or its methods for applying them are significantly inconsistent with IDEM's assessment methodology, ORSANCO's data are evaluated against IDEM's assessment methodology and the results are compared to Indiana's WQS to make the assessment. IDEM's methods for applying ORSANCO's assessments and/or data for the purposes of Integrated Reporting is described below and summarized in Table 3.

Aquatic Life Use Assessments for the Ohio River

ORSANCO uses both water chemistry results and biological monitoring results to determine the degree to which the Ohio River supports aquatic life. ORSANCO's fish community assessments of the Ohio River use the Ohio River Fish Index (ORFIn), which was developed based on the nationally used Index of Biotic Integrity (IBI) designed to assess smaller streams. The ORFIn has been customized to assess the Ohio River, with expected values developed for the different habitats found in this large river system. The ORFIn combines various attributes of the fish community to give a score to the river based on its biology. The total score is compared to an expected score, which varies depending on the habitat type and location. IDEM defers to ORSANCO's assessments based on biological data. IDEM also defers to ORSANCO's approach to evaluating water chemistry data. However, assessments may differ somewhat depending on the parameter in question and whose criterion, ORSANCO's or Indiana's, is more stringent (CALM Appendix A).

Recreational Use Assessments for the Ohio River

Indiana's E. *coli* criteria are slightly more stringent than ORSANCO's. However, unlike Indiana's WQS, ORSANCO's criteria do not allow exceptions for exceedances which are incidental and attributable solely to E.*coli* resulting from the discharge of treated wastewater from a wastewater

treatment plant. ORSANCO's assessment methodology also directly applies its single sample maximum criterion to individual results, which provides a more robust assessment than Indiana's combined criteria and assessment methodology can. Indiana therefore defers to ORSANCO's assessments of recreational use support for the Ohio River.

Fish Consumption Assessments for the Ohio River

In addition to assessments of aquatic life use support and recreational use support, ORSANCO also makes assessments of the degree to which the Ohio River supports fish consumption. In applying these assessments to Indiana reaches of the Ohio River, IDEM emphasizes that this information is not intended to be a public health advisory and recommends that the public refer to the most current Indiana Fish Consumption Advisory (FCA) or contact the Indiana State Department of Health (ISDH), or both with any specific questions or concerns regarding the health risks associated with consuming fish caught from the Ohio River. Important differences between fish consumption use impairments identified as a result of these assessments and the health advisories provided in the FCA are discussed in more detail in the section of this methodology describing Indiana's assessment methodology for fish consumption for other Indiana waters and Lake Michigan.

ORSANCO uses both fish tissue data and water sample results to make its fish consumption use assessments, and its methods for evaluating the data differ somewhat from IDEM's methods for similar assessments on other Indiana waters. Unlike ORSANCO's methodology, IDEM's assessment methodology relies on fish tissue data only and requires only one exceedance of the applicable criterion to assess impairment. IDEM's methods are intended to result in a more conservative estimate of conditions in smaller rivers and streams for which there is commonly less available data.

In contrast, the Ohio River is a large and complex river system, and the ORSANCO monitoring programs that provide data for the assessment of fish consumption use support result in a far more robust data set than those available for similar assessments of other Indiana waters. IDEM's collaboration with ORSANCO allows IDEM to focus its monitoring resources on other waters, and as a result IDEM's monitoring on the Ohio River is comparatively quite limited.

For most of the Ohio River, IDEM defers to ORSANCO's assessment methodology for fish consumption use support. For those reaches where IDEM has sampled for fish tissue, results for methylmercury and PCBs in fish tissue are reviewed independently of ORSANCO results using the same methods applied to other waters in the state. Where IDEM's assessment for a given reach differs from ORSANCO's assessment, IDEM defers to ORSANCO's assessment because the latter is typically based upon a more recent and robust data set.

In 2012, ORSANCO's technical committee approved the use of U.S. EPA guidance issued in 2010 for implementing the national methylmercury water quality criterion in CWA programs. However, the technical committee had concerns regarding the sufficiency of the available data with regard to trophic level representation. It was determined that some of the trophic levels were not adequately represented in the available data. Given this, while ORSANCO approved of the assessment method, it did not implement the method in its Ohio River assessment for the 2012 cycle. ORSANCO is currently working to develop minimum data requirements for its fish consumption assessments for mercury in fish tissue so that it may implement the approved methodology in future cycles.

The criteria ORSANCO applies in its fish consumption assessments are shown in Table 4. ORSANCO's criterion for methylmercury in fish tissue is equivalent to that used by IDEM in its fish consumption assessments on other waters. . ORSANCO's assessment methodology does not include a similar criterion for PCBs in fish tissue. Therefore, in cases where IDEM has results for PCBs in fish tissue from Ohio River fish, IDEM evaluates the results using ORSANCO's methods and the criterion

applicable to other Indiana waters.

In addition to fish tissue data, ORSANCO's monitoring programs provide results for PCBs, dioxin, and total mercury in the water column. For PCBs and dioxin, ORSANCO's criteria are more stringent than those expressed in Indiana's WQS.

Table 3: Water quality assessment criteria for determining designated use support for the Ohio River.

Aquatic Life Use Support – Ohio River		
Toxicants	Results for dissolved metals, total mercury, total selenium, free cyanide, and ammonia were evaluated on a site-by-site basis and judged according to the magnitude of the exceedance(s) of the applicable criteria in Indiana's WQS or ORSANCO's Pollution Control Standards (PCS), whichever is more stringent and the number of times the exceedance(s) occurred.	
	Fully Supporting	**Not Supporting**
	No more than 10% of all samples exceed applicable criterion for a given pollutant.	More than 10% of all samples exceed applicable criterion for a given pollutant.
Dissolved Oxygen (DO) and Temperature	Daily averages from hourly DO measurements and period averages from hourly temperature measurements were evaluated for the exceedance(s) of the applicable criteria in Indiana's WQS or ORSANCO's PCS, whichever is more stringent and the number of times the exceedance(s) occurred. Where exceedances are sufficient to impair, results are reviewed against any available biological data, Ohio River Fish Index (ORFin) scores, for the site to determine impairment.	
	Fully Supporting	**Not Supporting**
	For DO, the daily averages for 10% or less of days falls below 5mg/L. And Biological data for the same reach indicates full support (more than 25% of sites in a pool receive passing ORFin scores. Or No biological data are available for the site but the daily averages for 10% or less of days fall below 5mg/L. For temperature, no more than 10% of the periods exceed the period average And Biological data for the same reach indicates full support (No more than 25% of sites in a pool receive failing ORFin scores) Or No biological data are available for the site but 10% or less of the periods exceed the applicable period average.	For DO, the daily averages for more than 10% of days fall below 5 mg/L And Biological data for the same reach indicates impairment (25% or more of sites in a pool receive failing ORFin scores. Or No biological data are available for the site but the daily averages for more than 10% of days fall below 5 mg/L. For temperature, more than 10% of the periods exceed the period average And Biological data for the same reach indicates impairment (More than 25% of sites in a pool receive failing ORFin scores) Or No biological data are available for the site but more than 10% of the periods exceed the applicable period average.

Conventional Inorganics	Results for pH, sulfates, and chlorides were evaluated for the exceedance(s) of the applicable criteria in Indiana's WQS or ORSANCO's PCS, whichever is more stringent and the number of times the exceedance(s) occurred.	
	Fully Supporting	**Not Supporting**
	No more than 10% of all samples exceed applicable criterion for a given pollutant.	More than 10% of all samples exceed applicable criterion for a given pollutant.
Ohio River Fish Index (ORFin) scores	ORFin scores are compared to expected scores for the location sampled. Expected scores vary depending on the habitat type and location.	
	Fully Supporting	**Not Supporting**
	No more than 25% of sites in a pool receive failing ORFin scores	More than 25% of sites in a pool receive failing ORFin scores
Fish Consumption Use Support (Human Health) – Ohio River		
ORSANCO monitoring results for total mercury, PCBs and dioxin in water samples were evaluated for the exceedance(s) of the applicable criteria in Indiana's WQS or ORSANCO's PCS, whichever is more stringent and the number of times the exceedance(s) occurred. ORSANCO results for methylmercury in fish tissue samples were evaluated for the exceedance(s) of the applicable criteria in Indiana's WQS or ORSANCO's PCS, whichever is more stringent and the number of times the exceedance(s) occurred. For sites where ORSANCO's water sample results conflict with its fish tissue results for the same pollutant, the fish tissue results are given precedence. ORSANCO does not monitor for PCBs in fish tissue. IDEM results for methylmercury and PCBs in fish tissue are reviewed independently of ORSANCO results using the same methods applied to other waters in the state. Where IDEM's assessment for a given reach differs from ORSANCO's assessment, IDEM defers to ORSANCO's assessment.		
	Fully Supporting	**Not Supporting**
Polychlorinated biphenyls (PCBs) and Dioxin in Water Samples	No more than 10% of water sample results exceed the applicable water quality criterion	More than 10% of water sample results exceed the applicable water quality criterion
Polychlorinated biphenyls (PCBs) in Fish Tissue Samples	Actual concentration values for all samples are $\leq$0.02 mg/kg wet weight	Actual concentration values for one/more samples are >0.02 mg/kg wet weight
Mercury in Fish Tissue and Water Samples	For reaches with results from both water and fish tissue samples no more than 10% of fish tissue results exceed 0.3 mg/kg wet weight For reaches with results from either water samples or fish tissue samples but not both, no more than 10% of results from all samples exceed the applicable criterion	For reaches with results from both water and fish tissue samples, more than 10% of fish tissue sample results exceed 0.3 mg/kg weight wet For reaches with results from either water samples or fish tissue samples but not both, more than 10% of results from all samples exceed the applicable criterion

Recreational Use Support (Human Health) – Ohio River		
Available data are evaluated in two ways. Both individual results and monthly geometric mean results calculated from five samples, one collected each week for five consecutive weeks are evaluated for exceedances of the applicable criteria in ORSANCO's PCS and the number of times exceedances occurred.		
	Fully Supporting	**Not Supporting**
Bacteria (*E. coli)*	No more than 10% of the monthly geometric mean results exceed the geometric mean criterion of 130 cfu/100mL And No more than 10% of all single sample results exceed the instantaneous maximum criterion of 240 cfu/100 mL	More than 10% of the monthly geometric mean results exceed the geometric mean criterion of 130 cfu/100mL Or More than 10% of all single sample results exceed the instantaneous maximum criterion of 240 cfu/100 mL

With regard to mercury in the water column, ORSANCO's chronic aquatic life use criterion for total mercury in ambient waters is equivalent to Indiana's chronic aquatic life use criterion for total mercury. ORSANCO applies this criterion in its assessments of fish consumption use support as opposed to aquatic life use support because it considers bioaccumulation of mercury in fish tissue more of a human health concern than a threat to aquatic life. IDEM concurs with ORSANCO's use of water column results for mercury in assessments of fish consumption use based on this rationale and defers to ORSANCO on its fish consumption use assessments for the Ohio River. Unlike ORSANCO, IDEM also applies the chronic criterion for total mercury in its assessments of aquatic life use support on the Ohio River.

For sites where the results for total mercury and/or PCBs in water conflict with the fish tissue results for that same contaminant, the fish tissue results are given precedence. Fish tissue contaminants data are given more weight in the assessment decision because fish tissue levels of these contaminants are an indicator of more direct potential mercury exposure to individuals consuming fish from the Ohio River while their concentrations in the water column are more an indicator of potential bioaccumulation than direct impacts from consumption. IDEM concurs with this approach.

Table 4: Assessment criteria used by ORSANCO and IDEM to determine fish consumption use support for the Ohio River.

Mercury (Hg)		
	Fully Supporting	**Not Supporting**
Concentration in Fish Tissue	≤0.3 (mg/kg wet weight)	> 0.3 (mg/kg wet weight)
Concentration in Water	<0.012 ug/L	>0.012 ug/L
Polychlorinated Biphenyls (PCBs)		
	Fully Supporting	**Not Supporting**
Concentration in Fish Tissue	≤0.02 (mg/kg wet weight)	> 0.02 (mg/kg wet weight)
Concentration in Water	<0.000064 ug/L	>0.000064 ug/L
Dioxin		
	Fully Supporting	**Not Supporting**
Concentration in Water	< 0.000000005 ug/L	> 0.000000005 ug/L

LAKES ASSESSMENTS

IDEM's CWA Section 305(b) Assessment Criteria for Recreational Use Support in Lakes

IDEM's lakes assessments have largely been limited to CWA Section 314 assessments of lake trends and trophic state. This has been due to the absence of water quality criteria in the state's WQS. Indiana's WQS contain narrative criteria for all waters of the state. The few designated use assessments made on lakes and reservoirs to date are based primarily on narrative criteria.

On a national scale the number one impairment of lakes and reservoirs has long been identified as nutrients. Given this, U.S. EPA has mandated that states develop and adopt nutrient criteria their WQS. In 2001, EPA published recommended criteria for both causal (total nitrogen and phosphorus) and response (chlorophyll *a* and turbidity or water clarity) variables in the federal register (66 FR 1671). These criteria were developed for waterbodies in "aggregated" ecoregions based on the work of Omernik and Gallant (1988). U.S. EPA's ecoregional approach uses lake data from a number of states. The analyses used to derive the criteria applicable to Indiana included only nine Indiana lakes, one natural lake and eight reservoirs. Given this, U.S. EPA's published criteria are not as Indiana-specific as IDEM believes is necessary to provide for accurate assessments of water quality conditions in lakes throughout the state. U.S. EPA recognizes these concerns and encourages states to modify or refine their criteria to reflect conditions on a smaller geographic scale (U.S. EPA, 2000c).

In 2007, IDEM developed additional criteria for assessing recreational use support in lakes and reservoirs within the context of aesthetics in order to more fully assess the water quality condition of Indiana's lakes and reservoirs. It should be noted that the assessment criteria described here does not replace any assessment criteria currently in place for lakes and reservoirs. The assessment criteria for recreational use support with respect to human health remains unchanged as do those used to determine drinking water and aquatic life use support (Table 2).

These criteria used to determine recreational use support within the context of aesthetics are based on the results of a study conducted by of Limno-Tech, Inc. (LTI). In 2004, IDEM contracted with

LTI to recommend potential nutrient water quality criteria for Indiana's lakes based on data collected throughout Indiana over several decades. Under this project, a comprehensive database of lakes data was developed for use in analyzing nutrient relationships for Indiana's lakes. The final report for this study was submitted to IDEM in 2007. For the purposes of this notice, a summary of the data and analytical methods used and the resulting recommendations are provided here.

Phosphorus thresholds for recreational use assessments and the data used to develop them.

The LTI study used both agency data and volunteer data collected by the Indiana CLP from 321 natural lakes and 113 reservoirs from 1989 to 2005. Of the 13,063 individual samples with water quality data, 70% of the samples were collected under the volunteer monitoring program. In order to have sufficient data for robust analyses, it was important to use volunteer data if its reliability could be verified. The Indiana CLP is funded by IDEM's Section 319 grant program and operates under an IDEM-approved Quality Assurance Project Plan (QAPP), which documents the data quality of all data collected under the program.

Given the importance of volunteer data to this study, data were examined to determine if there was a significant difference depending on whether the data were collected by volunteers or the agencies. LTI first plotted raw data values against each other. However, it became apparent that averaged data provided a much better representation of potential relationships. For example, Figure 2 shows the growing season (June to August) average of Secchi depth and chlorophyll a (Chla) values for lakes where at least three different sample years of Chla existed. This analysis shows that volunteer data are indistinguishable from agency data, and, therefore, no bias should exist if all datasets are combined. Similar conclusions were reached when LTI made additional comparisons between Secchi depth and total phosphorus (TP) and between Chla and TP. The absence of bias between volunteer and agency data was also confirmed by evaluating lakes where agency and volunteer data were used to calculate summer medians versus lakes where only agency data were available.

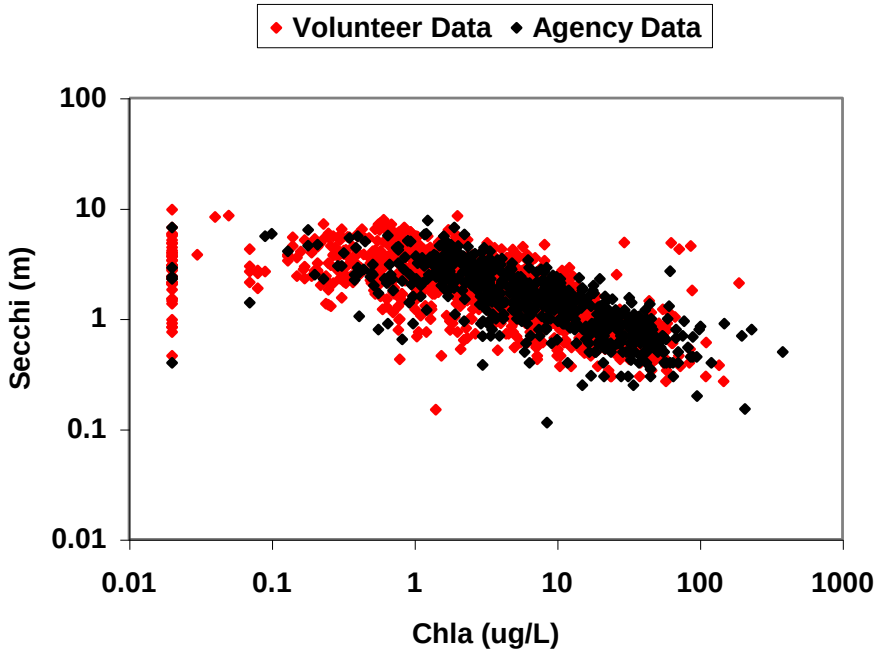


Figure 2: Comparison of volunteer and agency data (Source: LTI, 2007).

Data from all sources were reviewed for quality assurance and evaluated to identify

spatial and temporal patterns. Suitable models for developing criteria were evaluated and statistical analyses were applied to establish the recommended total phosphorus thresholds, which are shown in Table 5.

Table 5: Recommended phosphorus thresholds.

Lake Type	Total Phosphorus (ug/L)	Associated Range in Chlorophyll a (ug/L)
Natural Lakes	54	4 to 20
Reservoirs	51	2 to 25

Source: Modified from LTI (2007).

The associated range of Chla represents the range of concentrations that based on LTI's analysis of natural lakes and reservoirs in Indiana that can be expected when TP concentrations are at or below 54 ug/L or 51 ug/L, respectively.

How the thresholds were determined

Multiple linear regression analyses were conducted on total phosphorus (as a response variable) for each data set (natural lakes and reservoirs) using regression tree analysis (RTA) methods developed by Soranno, *et.al*, (personal communication). RTA was used to determine appropriate TP thresholds.

Once the TP thresholds were established, median values above and below the threshold for each lake type were calculated for two biological response variables, Secchi depth and Chla. The median values above and below represent the range of expected values for each response variable associated with its corresponding TP threshold. For example, in Figure 3, the median below line represents the median of all Chla concentration values that fall to the left of the calculated TP threshold whereas the median above line represents all of the Chla values that fall to the right of the threshold (that is, correspond to TP "exceedances"). A simplified model of how the median values calculated for a given TP threshold are used to determine recreational use support is provided in the discussion regarding IDEM's assessment methodology for this use (Figure 4).

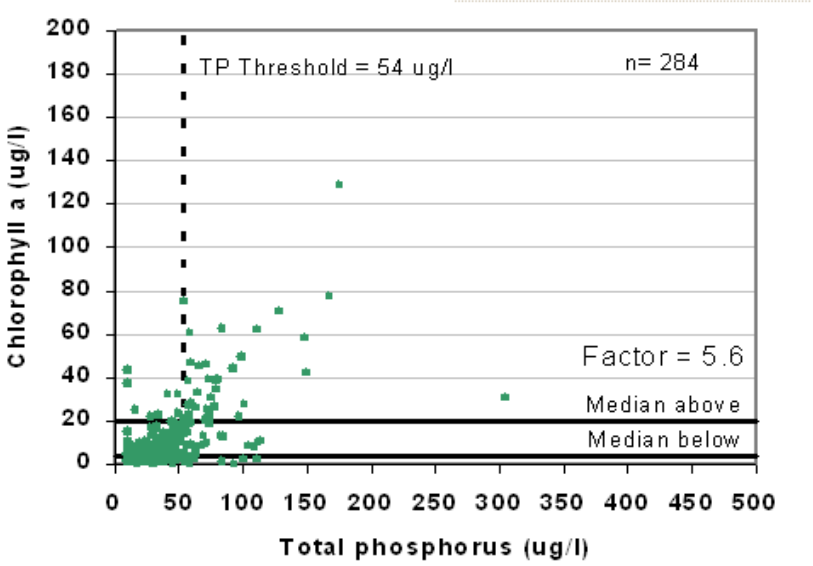


Figure 3: Relationship of Chlorophyll a concentrations to the TP threshold for natural lakes (Source: LTI, 2007).

A biological response factor for Chla was then calculated as the median of the biological response above the threshold divided by the median of the biological response below the threshold. The biological response factor for Secchi depth was calculated as the median of the biological response below the threshold divided by the median of the biological response above the threshold. Based on the work of Soranno, *et al.*, a biological response factor of 2 or greater is considered significant and could reasonably be designated as a relevant TP threshold above which action should be taken.

Table 6 shows that the thresholds calculated are very significant for Chla in both reservoirs and natural lakes. The threshold for Secchi depth in reservoirs, while still significant, is not nearly as strong as the threshold for Chla as indicated by their biological response factors (3.6 for Secchi depth vs. 13.2 for Chla). The same holds true for natural lakes (1.9 for Secchi depth and 5.6 for Chla), and the biological response factor for Secchi depth falls below that which is considered significant for the purposes of setting an appropriate TP threshold.

Table 6: TP thresholds and median values above and below the thresholds for natural lakes and reservoirs.

Response Variable	Secchi Depth	Chlorophyll a
Natural Lakes		
TP Threshold (ug/L)	36	54
Median of values above TP threshold	1.2 meters	20 ug/L
Median of values below TP threshold	2.4 meters	4 ug/L
Biological response factor	1.9	5.6
Reservoirs		
TP Threshold (ug/L)	31	51
Median of values above TP threshold	0.8 meters	25 ug/L
Median of values below TP threshold	2.7 meters	2 ug/L
Biological response factor	3.6	13.2

Source: Modified from LTI (2007).

Because the TP thresholds for Chla are much stronger than those for Secchi depth, IDEM's assessment methodology incorporates the TP thresholds developed for Chla. Other reasons for this decision are that Secchi depth measurements are inherently more subjective than Chla measurements, and IDEM does not have survey data regarding aesthetics, which is necessary to adequately translate secchi depth information into use support status. While there is similarly little analogous information available for Chla, IDEM considers Chla data obtained through laboratory analyses of water samples a more reliable indicator of phosphorus enrichment than secchi depth for the purposes of 305(b) assessment and 303(d) listing decisions.

In some cases, the Chla data were not consistent with expectations given the TP levels measured for a given lake (for example, low Chla values associated with high TP values or vice versa). For these situations, IDEM's methodology used the TSI score as a surrogate response variable (in addition to Chla) to determine impairment status. The TSI score can be affected by a number of variables in addition to phosphorus (see Table 8). However, the index places additional weight on algal concentration, adding significantly more points where concentrations are high. While the TSI does not provide a direct response variable for TP, it can be a useful indicator in cases where Chla results are mixed.

In addition to providing a surrogate measure for Chla, the TSI score also provides a good measure of overall trophic condition of a given lake. Recognizing the connection between trophic status and nutrient enrichment, U.S. EPA generally considers hypereutrophic conditions as measured by the TSI indicative of impairment (U.S. EPA, 2000c). IDEM does not believe that the TSI score alone is sufficient information for making designated use assessments because it can be affected by a number of variables in addition to nutrient loading. However, in cases where the Chla results are mixed, IDEM used the most recent TSI score to determine impairment. If the TSI score indicates eutrophic or hypereutrophic conditions, the lake was assessed as impaired. It should be noted that TSI scores were not used in absence of Chla results. TSI scores were only reviewed in cases where there were sufficient TP and Chla data but where those data showed conflicting results.

The benchmarks from the LTI study were used to make assessments for recreational uses (as opposed to other designated uses), specifically within the context of aesthetics. Because IDEM does not have sufficient information regarding the response of aquatic communities to

nutrient enrichment, these criteria are used to make recreational use support determinations only. These assessments are made within the context of aesthetics as opposed to health risk. Recreational use support assessments for human health are based on pathogen data and are made in the same manner as for rivers and streams when adequate data are available. All impairments identified based on this methodology were assessed as impaired for phosphorus as opposed to nutrients because the LTI study did not include analyses of other nutrient-related parameters.

Figure 4 provides a simplified model of how the median values calculated for a given TP threshold are used to determine recreational use support. A more detailed discussion is provided in following section.

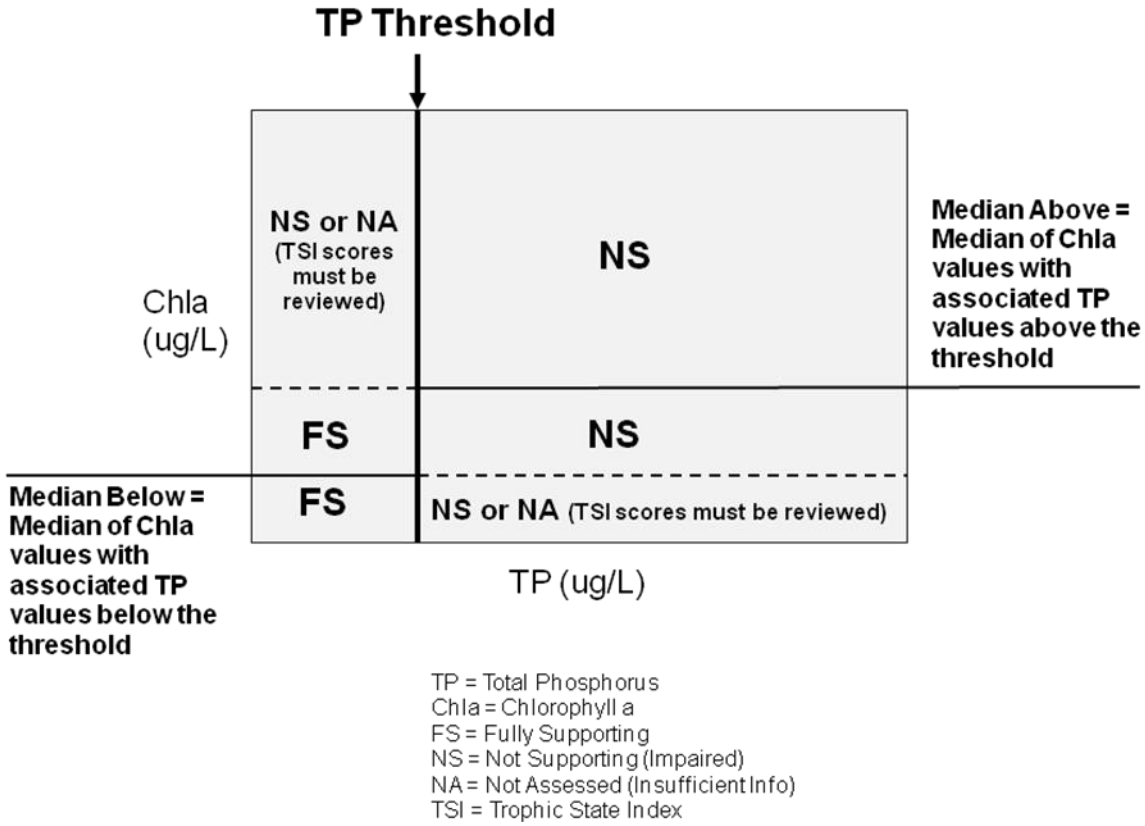


Figure 4: Simplified model of IDEM's assessment methodology using TP data in conjunction with Chla data.

IDEM's assessment methodology using the Total Phosphorus (TP) thresholds

Step 1. Determine the available data to be used for assessment

Indiana's CLP samples 70-80 lakes each year in accordance with a rotating sampling strategy similar to the rotating basin strategy employed by IDEM for monitoring streams. However, the basin rotation IDEM employs for Indiana's rivers and streams does not work well for lakes given their unequal distribution across the Indiana landscape. While some basins contain very few lakes, others contain more than can feasibly be sampled in a given year. Instead, the Indiana's CLP monitoring rotation for lakes is designed to analyze all public access lakes once every five years. Through this rotation, a given lake is monitored approximately once every five years in July and August with approximately 80 lakes sampled each year. About 400 lakes are thus monitored in a given five-year rotation. In general, only public lakes having an accessible boat launching area were sampled. The July-August period is used because this is the

time of year when worst-case scenario and stable conditions (warm temperatures, thermal stratification, hypolimnetic anoxia, and algal blooms are expected).

All available data for a given lake were used for assessment purposes. U.S. EPA guidance suggests that, while all readily available data should be reviewed, 305(b) assessment decisions should be based on data five years old or less. The use of historical data is necessary because the sampling conducted by IDEM's CLP program is designed specifically to support CWA Section 314 assessments of trophic state and lake trends, not to make designated use assessments. As a result, while IDEM's CLP sampling strategy ensures sufficient samples for determining trophic state and trends, a given CLP sampling rotation does not guarantee sufficient data for making designated use assessments (see Table 1 for minimum data requirements). IDEM's benchmark criteria were developed using data from 1989 forward. U.S. EPA recommends that, in general, the method of data gathering for determining compliance (in this case, designated use support) for lakes and reservoirs should be similar to that used to establish the criteria (U.S. EPA, 2000c). CLP data used for designated use assessments includes results from the following:

- One-time samples collected from public access lakes by students at Indiana University's School of Public and Environmental Affairs and analyzed in the CLP laboratory, and
- Monthly TP and Chla samples collected from public and private lakes by trained volunteers and sent to the CLP laboratory for analysis.

Step 2. Determine adequate data for assessment

For purposes of determining recreational use support within the context of aesthetics, the following general rules were applied:

- Only TP and Chla data, including volunteer-collected data, analyzed in the CLP laboratory in accordance with the CLP QAPP were used for assessment purposes.
- A minimum of three years' worth of data was considered sufficient for assessment purposes, provided each TP value had a corresponding Chla value.
- Multiple results within a given year for each parameter (TP and Chla) were averaged to provide a single value for that year.
- For consistency in assessments, all samples used in attainment decisions must have been collected during the summer season.

Step 3: Apply benchmark criteria to determine use support

The thresholds shown in Table 6 were applied to all natural lakes and reservoirs for which sufficient data were available. IDEM's methods for applying these criteria are summarized in Table 7 and are illustrated in Figure 5. All waters found to be not supporting of recreational use (aesthetics) were categorized as impaired and placed in Category 5A of Indiana's 303(d) list.

Table 7: Summary of IDEM's assessment methodology for recreational use support within the context of aesthetics.

Recreational Use Support (Aesthetics) – Lakes and Reservoirs		
	Fully Supporting	**Not Supporting**
Natural Lakes	No more than 10% of all TP values >54 ug/L and their associated Chla values are <20ug/L	Less than 10% of all TP values are >54 ug/L but their associated Chla values are >20ug/L, and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values <4ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >54 ug/L with associated Chla values >4ug/L
	Fully Supporting	**Not Supporting**
Reservoirs	No more than 10% of all TP values >51 ug/L and their associated Chla values are <25ug/L	Less than 10% of all TP values are >51 ug/L but their associated Chla values are >25 ug/L and the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values <2ug/L, but the TSI score for the lake indicates eutrophic (32-46) or hypereutrophic (>47) conditions Or More than 10% of all TP values are >51 ug/L with associated Chla values >2ug/L

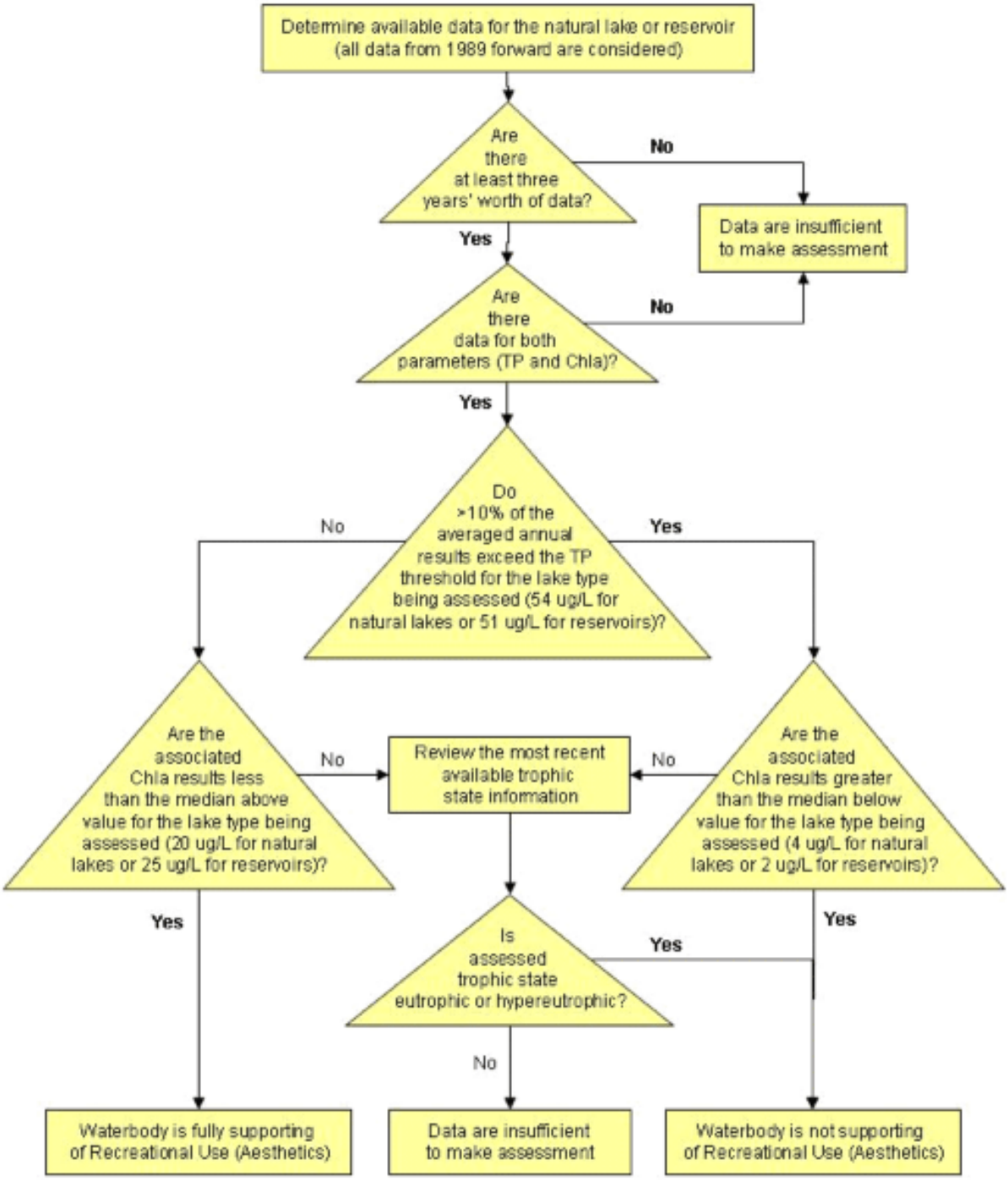


Figure 5: IDEM's assessment process for determining recreational use support for lakes within the context of aesthetics.

Given the robust, Indiana-specific dataset upon which the thresholds recommended in the LTI study were developed, IDEM believes they are appropriate for making designated use assessments and will likely provide the basis for rulemaking to establish nutrient criteria for Indiana's lakes in the future. When IDEM finalizes its nutrient criteria and incorporates them into the state's WQS, IDEM will review all lakes assessments made with the present methodology to determine their consistency with the revised WQS.

IDEM's CWA Section 314 Lakes Assessments

CWA Section 314 lakes assessments were based on the Indiana Trophic State (or eutrophication) Index, a modified version of the BonHomme Index developed for Indiana lakes in 1972. This multi-metric index combines chemical, physical, and biological data into one overall trophic score for each public lake and reservoir sampled (Table 8). Scores range from zero to 75. Lower values reflect lower concentrations of nutrients (Table 9). This information is useful in evaluating watershed impacts on lakes. Declining or extirpated cisco populations and the presence of exotic and potentially toxic blue-green algae species were also considered when evaluating lake water quality for aquatic life use. For drinking water reservoirs, taste and odor were also considered as potential indicators of other water quality problems within the waterbody.

Table 8: The Indiana Trophic State Index

Parameter	Range	Eutrophy Points
Total Phosphorus (mg/L)	<0.03	0
	0.03-0.039	1
	0.04-0.059	2
	0.06-0.199	3
	0.20-0.99	4
	≥1.0	5
Soluble Phosphorus (mg/L)	<0.03	0
	0.03-0.039	1
	0.04-0.059	2
	0.06-0.199	3
	0.2-0.99	4
	≥1.0	5
Organic Nitrogen (mg/L)	<0.5	0
	0.5-0.59	1
	0.6-0.89	2
	0.9-1.9	3
	≥2.0	4
Nitrate (mg/L)	<0.3	0
	0.3-0.39	1
	0.4-0.89	2
	0.9-1.9	3
	≥2.0	4
Ammonia (mg/L)	<0.3	0
	0.3-0.39	1
	0.4-0.59	2
	0.6-0.99	3
	≥1.0	4

Dissolved Oxygen (% saturation at a depth of five feet)	≤114	0
	115 to 119	1
	120 to 129	2
	130 to 149	3
	≥150	4
Dissolved Oxygen (% of measured water column with at least 0.1 ppm dissolved oxygen)	≤28	4
	29-49	3
	50-65	2
	66-75	1
	76-100	0
Light Penetration (depth in feet measured with a Secchi disk)	≤5	6
	>5	0
Light Transmission (% at a depth of three feet as measured with a photocell)	0-30	4
	31-50	3
	51-70	2
	≥71	0
Total Plankton (organisms/L as measured in a sample collected from a single vertical tow between the surface and the 1% light level)	<3,000	0
	3,000-6,000	1
	6,001-16,000	2
	16,001-26,000	3
	26,001-36,000	4
	36,001-60,000	5
	60,001-95,000	10
	95,001-150,000	15
	150,001-500,000	20
	>500,000	25
	Dominance of blue-green algae (≥ 50%)	10 additional points

Table 9: Indiana's lake classification in terms of trophic condition.

Trophic State		Indiana TSI Score
Increasing TSI scores indicate increasing eutrophication	Oligotrophic	≤15 TSI points
	Mesotrophic	16-31 TSI points
	Eutrophic	32-46 TSI points
	Hypereutrophic	≥47 TSI points
	Dystrophic	Lakes with little plant growth despite the presence of nutrients; usually due to high humic conditions

INDIANA'S ASSESSMENT METHODOLOGY FOR FISH CONSUMPTION FOR WATERS OTHER THAN THE OHIO RIVER

U.S. EPA "generally believes that fish and shellfish consumption advisories…based on reach specific information demonstrate impairment of CWA section 101(s) 'fishable' uses" and continues to require that IDEM make water quality assessments for fish consumption and place waters with fish consumption advisories on its 303(d) list of impaired waters (U.S. EPA, 2000a). However, Indiana's WQS (WQS) do not contain numeric criteria for the concentration of mercury or polychlorinated biphenyls (PCBs) in fish tissue. IDEM's past and present fish consumption use assessments are a translation of the narrative portion of Indiana's WQS, which states that surface waters "…shall be free from substances in concentrations that on the basis of available scientific data are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic to humans, animals, aquatic life or plants." (327 IAC 2-1-6 (a)(2)).

IDEM began using fish tissue data directly in its CWA assessments in 2008 to more accurately characterize the extent of impairment. Based on the guidance issued by U.S. EPA (U.S. EPA, 2010) and approved by ORSANCO's technical committee for use in Ohio River assessments, IDEM has refined its methods for evaluating mercury concentrations in fish tissue for its CWA 305(b) assessment and 303(d) listing processes for the 2012 cycle. These changes and their rationale are discussed in more detail in the following sections. The Agency's methods for evaluating PCB concentrations in fish tissue remain unchanged.

IDEM's Assessment Criteria for Mercury and PCB Concentrations in Fish Tissue

Mercury

In 2001, U.S. EPA issued a revised human health-based water quality criterion for methylmercury (U.S. EPA 2001). The new criterion is unique among all U.S. EPA (Clean Water Act 304(a)) water quality criteria in that it identifies an acceptable mercury concentration in fish tissue rather than water. A fish tissue criterion is logical because it is fish that are the main source of methylmercury exposure to both humans and wildlife. Also, a tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation, which can be a significant source of uncertainty. The derivation of the methylmercury water quality criterion is based on the reference dose of 0.1 ug/kg body weight/day, exposure data (i.e. the amount of methylmercury ingested, inhaled, or absorbed per day), and data about the target population to be protected. The U.S. EPA criterion (U.S. EPA 2001) is 0.3 mg/kg wet weight methylmercury in

fish muscle tissue. Since nearly 100 percent of the mercury in fish muscle is methylmercury, the criterion can reasonably be considered a total mercury criterion.

Polychlorinated Biphenyls (PCBs)

U.S. EPA has not issued a human health-based criterion for PCBs in fish tissue nor do Indiana's WQS contain a numeric concentration criterion for PCBs in the edible portion of fish tissue. However, Indiana has adopted human health WQS to protect the public from adverse impacts due to 1) exposure through public drinking water supplies withdrawn from surface waters and 2) nondrinking water exposures such as consumption of fish caught in Indiana lakes, rivers, and streams. Although human consumption of sport fish is not explicitly described in Indiana's WQS, criteria for fish consumption are included as part of the calculation of the human health criteria IDEM plans to propose in the future. The fish consumption values in the human health criteria calculation are intended to ensure that the levels of a carcinogenic chemical in fish are not at levels harmful to people who consume them.

Absent a U.S. EPA criterion derived specifically for fish tissue concentration of PCBs, using U.S. EPA's methodology for deriving ambient water quality criteria for the protection of human health (U.S. EPA 2006a) to calculate a concentration value for PCBs is a reasonable alternative that results in a criterion that is more readily applicable to Sections 305(b) and 303(d) water quality assessments than using FCA grouping levels.IDEM’s benchmark criteria for mercury and PCBs in fish tissue are shown in Table 10.

Table 10: WQS-based assessment thresholds for mercury and PCBs.

Mercury (Hg)		
Concentration in Fish Tissue	**Fully Supporting**	**Not Supporting**
	≤ 0.3 (mg/kg wet weight)	> 0.3 (mg/kg wet weight)
Polychlorinated Biphenyls (PCBs)		
Concentration in Fish Tissue	**Fully Supporting**	**Not Supporting**
	≤ 0.02 (mg/kg wet weight)	> 0.02 (mg/kg wet weight)

Relationship of IDEM’s WQS-Based Criteria to the FCA

A fish consumption advisory is determined based on the quantity of a chemical in fish, such as milligrams of chemical per kilogram of the edible portion of fish tissue (mg/kg). WQS, on the other hand, are expressed as the quantity of the chemical in water, such as micrograms of a chemical per liter of water (ug/L). The exposure assumptions upon which the human health criteria are based can be used to calculate a maximum safe fish concentration. That fish concentration value can then be directly compared to the values used to issue fish consumption advisories to determine whether the advisory is less or more protective than the WQS.

The levels of fish tissue contaminants that trigger a FCA and the levels of fish tissue contaminants on which the WQS criteria are based are derived using the same contaminant result, reference dose and body weight assumptions. Although EPA derived its recommended screening value for a fish advisory limit for mercury and human health methylmercury criterion from virtually identical methodologies, it is important to clarify the distinctions between the two values. They are consistently derived, but because each value differs in purpose and scope, they diverge at the risk management level. Fish advisories are intended to inform the public about how much consumers should limit their intake of individual fish species from certain waterbodies. Alternatively the criterion is used as the basis for nonregulatory and regulatory decisions. The criterion serves as guidance for use in establishing water quality standards which, in turn, serve as a benchmark for attainment, compliance, and enforcement purposes.

FCAs are intended to provide for protection of human health over a lifetime of exposure, maximizing benefits of eating fish while minimizing the risk. The calculations used to determine if an FCA should be issued are based on contaminant concentration found in fish, which is treated as a constant while consumption rates are allowed to vary (how much fish can one safely consume and not exceed a particular dose rate). Allowing for different consumption rates makes it possible to safely consume fish that have different levels of contamination. The recommended consumption rate is reduced as fish tissue contaminant concentrations increase. In contrast, WQS criteria calculations start with an assumed level of fish consumption and derive a criterion for a safe level of exposure. Because the consumption rate is held constant, the resulting criterion can be applied consistently to all waters. FCAs are expressed for a given waterbody in terms of certain species within certain size ranges, very few FCAs apply to all fish in a given waterbody, which limits their utility for water quality assessment purposes.

IDEM's assessment methodology for evaluating fish tissue data is directly applicable to all waters and uses the revised human health-based water quality criterion for methylmercury (U.S. EPA 2001) and a criterion for PCBs derived from U.S. EPA's (2000b) human health methodology.

While mindful of the differences in purpose and function of the FCA and the 303(d) list, IDEM's methodology maintains as much consistency as possible between the protocols ISDH, IDEM, and IDNR use to assess data for the FCA and the protocols IDEM uses to assess data for the determination of impairment. For PCBs, the WQS-based threshold is lower than the FCA threshold for a Group 2 advisory. Therefore, there is a concentration range where there could be a WQS exceedance but still unlimited consumption. However, the threshold for mercury is higher than that which would trigger a Group 2 advisory (Table 11). For mercury, given the existing exposure assumptions upon which the water quality criteria are based, issuance of a FCA does not necessarily indicate an exceedance of WQS.

Table 11: Fish tissue concentrations for levels of consumption advice protective of sensitive populations established by ISDH for mercury and total PCBs and its correspondence to an impairment condition as determine by the WQS-criteria.

Mercury	**Fish Tissue Concentration (mg/kg)**				
	<0.05	<0.05 – 0.2	0.2 – 1.0	1.0 – 1.9	>1.9
FCA Groups	Group 1	Group 2	Group 3	Group 4	Group 5
Consumption Advice (FCA)	unlimited	1 meal/ week	1 meal/ month	1 meal/ 2 months	No consumption
PCBs	**Fish Tissue Concentration (mg/kg)**				
	<0.05	<0.05 – 0.2	0.2 – 1.0	1.0 – 1.9	>1.9
FCA Groups	Group 1	Group 2	Group 3	Group 4	Group 5
Consumption Advice (FCA)	unlimited	1 meal/ week	1 meal/ month	1 meal/ 2 months	No consumption

*Shaded cells indicate consumption advice that corresponds to nonsupport and an impaired condition using the WQS-based criteria.

IDEM’s benchmark criteria do not reflect any determination by IDEM of what an appropriate fish consumption rate should be. The consumption rates expressed in Indiana’s WQS for human health are 15.0 g/day for waters in the Great Lakes basin (327 IAC 2-1.5-14) and 6.5 g/day for downstate waters (327 IAC 2-1-8.6). For mercury, IDEM defaulted to the U.S. EPA water quality criterion 0.3mg/kg methylmercury wet weight determined at a consumption rate of 17.5 g/day) for mercury in fish tissue and a reference dose of 0.1 ug/kg body weight/day (U.S. EPA, 2001a), which corresponds to approximately two meals per month, between a Group 2 (32 g/day) and a Group 3 (7.4 g/day) advisory.

For calculating the criterion for PCB in fish tissue, IDEM used the same consumption rate U.S. EPA used to calculate its criterion for mercury in fish tissue for the general population, which is 17.5 g/day national consumption rate. The use of a higher consumption rate in the PCB calculation is consistent with that used by U.S. EPA and results in a more protective criterion than applying the consumption rate expressed for either the Great Lakes basin or downstate waters. The same holds true for mercury. IDEM's decision to use U.S. EPA's criterion value for mercury in fish tissue was a policy decision based on the fact that U.S. EPA's criterion is more protective. Calculations for both criteria are provided at the end of this appendix.

Assessment method using the WQS-based criteria

IDEM's assessment methodology for evaluating fish tissue data is summarized in Table 12 and reflects a conservative approach intended to both identify waters in which the data indicate impairment for mercury and/or PCBs and to provide for the protection of human health.

For PCBs, all samples from a given sampling reach must have results below the benchmark for PCBs in order to be assessed as fully supporting, and all waters with a sample result exceeding the benchmark are classified as impaired. This is a highly conservative approach that considers only the highest sample PCB concentration, which may be one of a number of samples collected at the site.

For the 2008 and 2010 cycles, IDEM used the same approach to evaluate mercury in fish tissues as that used for PCBs. For the 2012 cycle, IDEM refined its assessment methods for mercury based on U.S. EPA's more recent guidance (U.S. EPA 2010), which provides recommendations on the use of U.S. EPA's water quality criterion for mercury in fish tissue in CWA 305(b) assessments. It should be noted that U.S. EPA's 2010 guidance did not change the methylmercury criterion that IDEM uses in these assessments nor how it is applied as it still requires only one exceedance of the criterion to trigger an impairment decision. Rather, the guidance provides a new approach to analyzing the data. Instead of evaluating each sample result from a given site individually, IDEM now calculates a single trophic level consumption rate weighted arithmetic mean result for the site based on all the samples collected during a given sampling event for the purposes of evaluating fishable use support for mercury. The calculation IDEM now uses for the purposes of evaluating methylmercury in fish tissue, which is provided at the end of this appendix, apportions the national default consumption rate of 17.5 g/day across three trophic levels based on the amount and type of fish (by trophic level) that people might be consuming and as such, more accurately characterizes human exposure and therefore fishable use support.

Table 12: Methods for determining fish consumption use support in Indiana waters.

Determining Use Support		
	Fully Supporting	**Not Supporting**
Mercury in Fish Tissue	Trophic level weighted arithmetic mean concentration values for all sampling events are ≤0.3 mg/kg wet weight	Trophic level weighted arithmetic mean concentration values for one or more sampling events are >0.3 mg/kg wet weight
PCBs in Fish Tissue	Actual concentration values for all samples are ≤0.02 mg/kg wet weight	Actual concentration values for one/more samples are >0.02 mg/kg wet weight

Sport fish are of particular importance to the question of consumption because they comprise the majority of fish taken by anglers. Most sport fish are predator species but also include omnivores such as carp. Therefore, to properly determine the degree to which a waterbody supports fish consumption, an appropriate methodology takes into consideration both

the types of fish being caught and how differences in species affects the concentrations of the contaminant in question. Prior to the release of U.S. EPA's 2010 guidance on the implementation of its water quality criterion for methylmercury in fish tissue, IDEM used the same methods to make fish consumption assessments for both contaminants.

The differences in IDEM's assessment methods for PCBs and mercury are a function of how these contaminants accumulate in the tissues of fish once ingested by them. PCB concentrations in fish are primarily a function of their fat content while mercury concentrations are more a function of their trophic level. Because PCBs accumulate in the fatty tissues of fish, concentrations tend to be higher in more fatty species such as carp and catfish as opposed to species such as bass and sunfish which are leaner by comparison. In contrast, mercury tends to be higher in predator species because it biomagnifies up the food chain as larger fish consume smaller fish containing mercury.

The method of calculating a trophic level weighted arithmetic mean for mercury would not be appropriate for PCBs because trophic levels are less predictive than individual species of PCB concentrations in fish caught at a given site and thus less representative of the amount of PCBs a person might consume. Based on the way that PCBs bioaccumulate in fish tissue (i.e. in their fatty tissue), IDEM continues to use individual samples results for the purposes of assessment, and the type of fish species continues to be a factor in assessment. Based on U.S. EPA's 2010 guidance, the particular species is no longer as relevant for evaluating total mercury concentration (most of which is methylmercury) in fish tissue, which is more a function of trophic level for determining fish consumption use support. For evaluating mercury in fish tissue, IDEM's revised methods use a trophic level geometric mean to calculate a consumption-weighted arithmetic mean for the site, which considers consumption levels across all trophic levels and includes all species types.

Given the change in its assessment methodology for mercury in fish tissue, IDEM conducted a statewide reassessment of all IDEM fish tissue data to ensure the accuracy of Indiana's 303(d) list with regard to impairments for mercury in fish tissue that were identified based on the previous method. The data set reviewed for this reassessment was comprised of results from sampling conducted from 1990-2011 and is IDEM's longest ranging and most complete fish tissue data set to date. IDEM emphasizes that in completing its statewide reassessment, no waterbody impairment previously identified on Indiana's 303(d) list was delisted due to the age of the data available for assessment.

IDEM's Decision Making Process for Determining the Degree to Which Indiana Waters Support Fish Consumption Based on Mercury and PCB Concentrations in Fish Tissue

The following describes in detail the steps in IDEM's assessment process for assessing the "fishable use" of Indiana waters, which are illustrated in Figure 6.

Step 1. Determine adequate data for assessment

In addition to data quality, the adequacy of a data set for the purposes of making 305(b)/303(d) assessment and listing decisions is measured by the amount of data available and the age of the data, both of which can affect the degree to which the data accurately represents waterbody conditions.

The previous minimum data requirements for fish tissue assessments still apply. One sampling event was considered sufficient for assessment purposes. At a given sampling event, composite samples were made for each species within a given size class collected at the site, which provides one/more species-specific results for assessment. For PCBs, results for each individual sample were compared to the 0.02 mg/kg criterion to make the assessment. For mercury, a consumption-weighted arithmetic mean was calculated for each sampling event using

the results from all the samples collected. The arithmetic mean result for each sampling event was then treated as an individual result and compared to the 0.3 mg/kg criterion. Multiple sampling events within a single year or multiple years for a site were not pooled together for either type of assessment (mercury or PCBs).

U.S. EPA guidance suggests that, while all readily available data should be reviewed, 305(b) assessment decisions should be based on data five years old or less. However, IDEM has established 12 years as the appropriate index period for the purposes of evaluating fish tissue data. Given the persistent nature of fish tissue contaminants in the environment, aggregating data over several years minimizes the effects of temporal, spatial, and species level variability on the assessment process. Based on IDEM's sampling strategy, an index period of 12 years ensure two full cycles of fish tissue data for use in evaluating fish consumption use support.

Data collected outside the index period were also evaluated, most often as supporting information where more recent data are available. Where there were no more recent data available, it should be noted that waters were not delisted based on age of data alone. In applying its revised assessment method for mercury, in cases where the original data used to make an impairment decision was outside the current index period, IDEM applied its revised methodology as follows: If the original data indicated impairment when evaluated based on its consumption-weighted arithmetic mean, the lake or stream reach remained assessed as impaired for mercury in fish tissue unless there were more recent results from within the 12-year period of assessment to indicate otherwise.

It should also be noted that a fully supporting assessment for mercury in fish tissue does not preclude the listing of a waterbody for an impairment of its fish consumption use. A waterbody is listed as impaired for fish consumption based on impairment for either fish tissue contaminant – mercury or PCBs.

Independent applicability was applied to all results obtained within the index period for assessment. By definition, the index period is the period of time over which the data may reasonably be considered representative of conditions in a given waterbody. A single, older result collected within the index period may well be representative of the variability within the waterbody and was considered equally valid as any other sample collected in the same index period.

Therefore, where there were conflicting results from samples collected within the index period, the waterbody was assessed as impaired regardless of when in the index period the exceeding results was collected and even if the more recent results indicate full support.

Step 2: Apply WQS-based concentration thresholds to determine use support

The WQS-based assessment thresholds shown in Table 10 were applied to all lakes and streams for which sufficient fish tissue data were available. IDEM's methods for applying these criteria are summarized in Table 9. All waters found to be not supporting due to either mercury or PCBs or both were categorized as impaired and placed in Category 5B of Indiana's 303(d) list.

Step 3: Determine the appropriate geographical extent to which the assessment applies

In some cases fish can be very mobile and difficult to attribute to a discrete portion of a lake or river reach. In determining the appropriate geographical extent to which results can be confidently applied, IDEM employed the following general rules. Unless otherwise stated, the same general rules were applied to assessments of both PCBs and mercury in fish tissue.

Stream Order Considerations

For flowing waters, stream order was the primary factor considered in determining the appropriate distance over which the results should be applied. Stream order is a good indicator of

relative stream size, and to the extent that size affects flow, the size of a given stream has a significant effect on species and sizes of fish that might be caught there.

Generally, in cases where significant differences in stream order exist in a given watershed, results were applied only to the stream on which they were obtained. This is because the fish community found in a third or fourth order stream might reasonably be expected to be very different from the fish communities found in its first and second order tributaries. Likewise, the expectations for the type and sizes of fish found in a fifth order stream would be different from those for a third or fourth order stream. Given this, results obtained from fifth order and greater streams were limited only to the mainstem and were not considered representative of their tributaries. Because of the significant effects that stream order has on the structure of the fish community in a given stream, basing extrapolations primarily on stream order allows us to more reliably apply fish tissue results on a stream-specific basis.

Most of Indiana's larger streams and rivers (third, fourth, and fifth order streams) have been monitored for many years resulting in very robust data sets. On these streams, results were applied to greater lengths where bounding samples upstream and downstream were available.

Results for many of Indiana's smaller streams (first and second order streams) are generally more limited. On these waters, results were applied only to the 12-digit watershed boundary except in cases where additional results from sites in an upstream or downstream watershed supported assessment over a greater distance. In these cases, assessments were limited to mainstem reaches between the sites and were not applied to their tributaries. Results from a mainstem site were also applied to their headwaters if obtained in the same watershed or the watershed immediately downstream.

Background Conditions

For PCBs, relative concentrations are used as an indicator of background conditions. For PCBs, values greater than 1000 ppb were considered suggestive of point sources, most of which are known legacy sources of this contaminant. Values lower than this can be reasonably attributed to atmospheric and biological redistribution of contaminants or low level nonpoint sources and were considered representative of background conditions. Therefore, for PCBs, monitoring results in smaller watershed were also extrapolated into tributaries of similar stream order when values were consistently low such as to suggest background conditions and/or where data were limited. Exceptions to this included situations where the sampling site was located in a particularly large and/or hydrologically complex watershed and/or the site was located far upstream from most or all tributaries in the watershed. Extrapolations around sites with very high PCB concentrations suggesting point sources were generally more limited.

Unlike PCBs, there is no concentration value for mercury that is considered particularly suggestive of point sources. High mercury values in fish tissue are more indicative of localized methylation processes affecting the amount of mercury available for uptake than any sources of contamination. Most mercury in fish tissue is the result of atmospheric deposition, which is diffuse in nature. As a result, background conditions for mercury in fish tissue are very difficult to determine because they are highly dependent on the structure of the fish community, which differs significantly depending on the size of the stream in question. While it may be possible to predict background conditions for a given stream order to guide extrapolations of results for mercury in fish tissue, stream order itself remains a more reliable indicator of the extent to which those results may be representative for the purpose of determining use support.

Results from Lake Samples

For a given lake or reservoir, all fish tissue data were aggregated unless there was evidence that fish from certain parts of the lake were isolated and may have been exposed to a

different level of contamination.

Fish community structure within a lake can clearly influence the fish community structure in out-flowing streams over some distance. Given this, results from lakes and reservoirs were applied downstream into adjacent watersheds in cases where there are downstream data to support the assessment. In cases where there were no data available for out-flowing streams, results for lake samples were applied only to the lake from which they were collected.

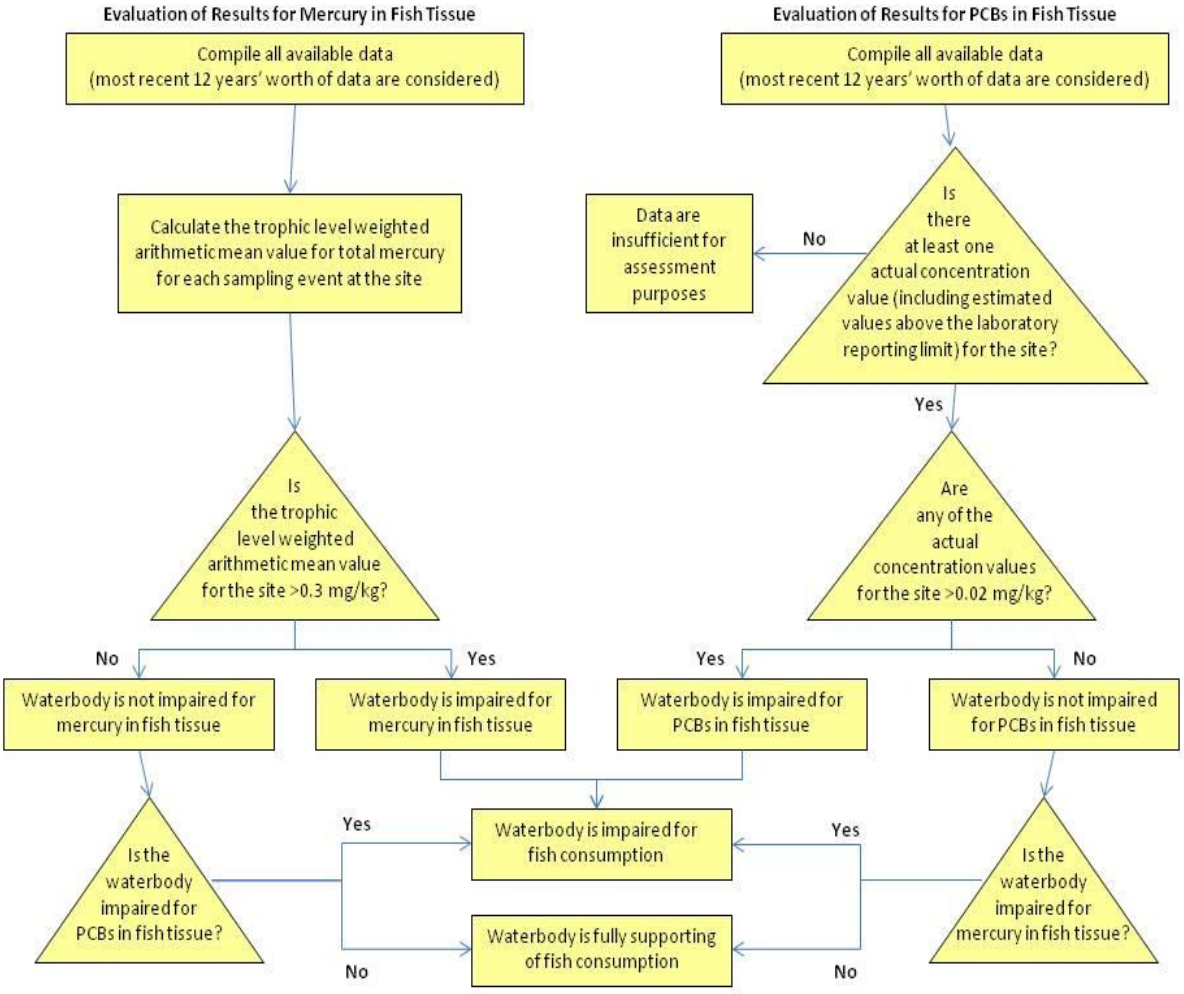


Figure 6: IDEM's process for determining fish consumption use support using results for mercury and/or PCBs in fish tissue.

How to interpret impairments for fish consumption identified on Indiana's 303(d) List of Impaired Waters

IDEM emphasizes that the purpose of the 303(d) list is not to provide the public with a list of waters that they should or should not swim in, or catch and eat fish from. Section 303(d) of the CWA requires that states develop a list identifying impairments to water quality for which a TMDL is required. The 303(d) list is not and was never intended to be a public health advisory. IDEM continues to defer to the Indiana FCA on questions regarding the relative risks of consuming fish caught from Indiana waters and recommends that the public refer to the current FCA and/or contact the Indiana State Department of Health with any specific questions or concerns in this respect. The current fish consumption advisory can be found online at: http://www.in.gov/isdh/23650.htm and contains more specific information than the 303(d) list does regarding the sizes and species of fish that can be safely consumed and how often.

Because IDEM uses the similar methods in determining unsafe levels of mercury and PCBs that ISDH uses in determining fish consumption advice, the concentrations of these contaminants used to determine impairment correspond closely to the meal frequency recommendations published in the FCA. However, it is important to emphasize that one cannot assume, because a particular waterbody does not appear on the 303(d) list for fish consumption that the fish in that waterbody are safe for consumption of more than one meal per week. Likewise, due to the statewide fish consumption advisory for carp, it should not be assumed that carp greater than 15" in length from waters assessed as fully supporting are safe for consumption of more than one meal per month for the general population or at all by sensitive populations. ***The 303(d) list is not intended to communicate health risk information.***

At present, adequate translators do not exist for applying concentrations of mercury or PCBs in fish tissue to concentrations in the water column. Toxicants may be present in fish at levels that have no ill effects on aquatic life but due to bioaccumulation may make them unsafe to eat. The concentrations shown in Table 10 apply only to fish tissue, not water. ***Therefore, it also should not be assumed that if a waterbody is impaired for fish consumption that mercury and/or PCBs are present in the water column in amounts harmful to human health.***

IDEM's fish consumption use assessments are required by U.S. EPA and are a translation of the narrative portion of Indiana's water quality standard, which states that surface waters "…shall be free from substances in concentrations that on the basis of available scientific data are believed to be sufficient to injure, be chronically toxic to, or be carcinogenic…to humans, animals, aquatic life or plants." (327 IAC 2-1-6 (a)(2)). In addition to resolving the issues associated with using the FCA for assessments, IDEM believes this assessment methodology is consistent with this standard, achieves consistency with the decision making criteria used in developing the FCA, and is consistent with U.S. EPA 305(b) and 303(d) policy guidance.

AQUATIC LIFE USE ASSESSMENTS

Use Support Criteria for Biological Data

Biological assessments for streams are based on the sampling and evaluation of either the fish communities or benthic aquatic macroinvertebrate communities, or both. Indices of Biotic Integrity (IBI) for fish and macroinvertebrate IBI (mIBI) assessment scores, or both, were calculated and compared to regionally calibrated models. In evaluating fish communities,

streams rating as "fair" or worse are classified as nonsupporting for aquatic life uses. For benthic aquatic macroinvertebrate communities, individual sites are compared to a statewide calibration at the lowest practical level of identification for Indiana. All sites at or above background for the calibration are considered to be supporting aquatic life uses. Those sites rated as moderately or severely impaired in the calibration are considered to be nonsupporting. Waters with identified impairments to one/more biological communities are considered not supporting aquatic life use. The biological thresholds Indiana uses to make use attainment decisions are shown in Table 13 to provide greater context for understanding the range of biological condition that is considered either fully supporting or impaired.

IDEM's aquatic life use assessments are never based solely on habitat evaluations. However, habitat evaluations are used as supporting information in conjunction with biological data to determine aquatic life use support. Such evaluations, which take into consideration a variety of habitat characteristics as well as stream size, help IDEM to determine the extent to which habitat conditions may be influencing the ability of biological communities to thrive. If habitat is determined to be driving a biological community impairment (IBC) and if no other pollutants that might be contributing the impairment have been identified, the IBC is not considered for inclusion on IDEM's 303(d) List of Impaired Waters (Category 5). In such cases, the waterbody is instead placed in Category 4C for the biological impairment.

Table 13: Biological thresholds used to determine aquatic life use support.

Biotic Index Score and Associated Assessment Decision	Integrity Class	Corresponding Integrity Class Score	Attributes
Macroinvertebrate community data collected with artificial samplers (used in assessments prior to 2010 cycle)			
mIBI ≥1.8 (artificial substrate sampler) indicates full support	Excellent	6.0-8.0	NA
	Good	4.0-5.9	NA
	Fair	1.8-3.9	NA
mIBI <1.8 (artificial substrate sampler) indicates impairment	Poor	1.0-1.7	NA
	Very Poor	0-0.9	NA
Macroinvertebrate community data collected using KICK methods (used in assessments prior to 2010 cycle)			
mIBI ≥2.2 (kick methods) indicates full support	Excellent	6.0-8.0	NA
	Good	4.0-5.9	NA
	Fair	2.2-3.9	NA
mIBI <2.2 (kick methods) indicates impairment	Poor	1.0-2.1	NA
	Very Poor	0-0.9	NA
Macroinvertebrate community data collected using multihabitat (MHAB) methods (used in assessments for 2010 cycle)			
mIBI ≥36 indicates full support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species.
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present.
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure.
mIBI <36 indicates impairment	Poor	23-35	Many expected species absent or rare, tolerant species dominant.
	Very Poor	12-22	Few species and individuals present, tolerant species dominant
	No Organisms	<12	No macroinvertebrates captured during sampling.
Fish community data			
IBI ≥36 indicates full support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species.
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present.
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure.

Biotic Index Score and Associated Assessment Decision	Integrity Class	Corresponding Integrity Class Score	Attributes
IBI <36 indicates impairment	Poor	23-35	Top carnivores and many expected species absent or rare, omnivores and tolerant species dominant.
	Very Poor	12-22	Few species and individuals present, tolerant species dominant, diseased fish frequent.
	No Organisms	<12	No fish captured during sampling.

Revisions to IDEM's Use Support Criteria for Biological Data

IDEM's use support criteria for fish community and macroinvertebrate community data have undergone significant changes since they were first adopted in 1996. Table 14 summarizes the evolution of IDEM's criteria for making assessments with biological data. The criteria developed for the 2004 305(b)/303(d) assessment and listing cycle are calibrated to reference conditions in Indiana and remain in effect today. However, with these changes and each change prior to that time, resulting criteria were applied only to the basins being assessed at the time. For the 2008 cycle, IDEM completed its review of all aquatic life use support assessments made prior to 2002 to identify any waterbodies that may now be considered fully supporting.

For the 2010 cycle, IDEM revised its assessment methods for evaluating macroinvertebrate data. The statewide mIBI was developed and calibrated using riffle/run samples collected throughout the state from 1990-1994. The riffle/run method was subsequently used by the Office of Water Quality from 1996 to 2003 to collect samples at some of the same sites sampled for the original calibration of the index randomly selected for follow-up sampling. Beginning in 1998, samples were also collected at probabilistic sites chosen for the Watershed Monitoring Program where a suitable riffle/run habitat was present. Unfortunately, less than half of the probabilistic sites sampled during this time had riffle/run type habitats within the allowed distance, which reduced the effectiveness of the riffle/run method as a monitoring tool. This necessitated the need to develop a macroinvertebrate sampling method which could be used at all probabilistic sites, regardless of habitat.

The new multi-habitat method (MHAB) differs primarily from the riffle/run method in that it samples all habitats available at a stream site using a D-frame net instead of the kick screen used in the riffle/run method. In 2004, 62 sites (a subset selected from all sites previously sampled with the riffle/run method between 1990 and 2003), were re-sampled with the new MHAB method. The idea was to develop an index calibrated, not on the best possible reference conditions, but on a normal distribution of stream conditions based on mIBI scores obtained at previously sampled sites. It was later determined that this was too few samples to develop an efficient statewide index; these samples were combined with probabilistic samples collected in 2005, 2006 and 2007 (a total of 247 samples) to develop the index currently in use.

Twelve metrics were chosen from a pool of more than 100 possible metrics in the development of the new mIBI. These 12 metrics provided the best correlation to the data and describe a diversity of features that characterize the quality of a stream or river. The scores for each individual metric are totaled and can range from 12 to 60. As with the fish community IBI, mIBI scores less than 36 are considered non-supporting of aquatic life use while those equal to or

greater than 36 are supporting of aquatic life use.

IDEM incorporated the mHAB methods into it monitoring programs in 2004 and began using the mIBI scores derived with the mHab methods beginning with the 2010-cycle assessments of aquatic life use support. At this time, IDEM is considering whether a reevaluation of waters previously assessed using the original mIBI is now in order. However, due to the differences in sampling methods used to obtain the data for the original mIBI and the new index now in place, such a reassessment may not be necessary or appropriate.

Table 14; Evolution of the criteria used in making aquatic life use assessments with biological data.

Cycle	Criteria Development and Changes
1998	IDEM used Karr's 1986 Index of Biotic Integrity (IBI) Classification and Attributes Table to establish criteria to apply to fish community (IBI) data for use support assessments: • IBI ≥ 44 = Fully supporting (Excellent/Good) • IBI < 44 and ≥ 22 = Partially supporting (Fair/Poor) • IBI < 22 = Not supporting (Very Poor/No Fish) IDEM's criteria for macroinvertebrate community (mIBI) data collected using kick methods: • mIBI ≥ 4 = Fully supporting • mIBI < 4 and ≥ 2 = Partially supporting • mIBI < 2 = Not supporting
2000	IDEM reviewed fish community data from 1990-1995 (n=831) to determine new, more accurate limits reflective of Indiana fish communities by subtracting ½ standard deviation from the statewide mean to calculate the following criteria: • IBI > 34 = Fully supporting • IBI < 34 and > 32 = Partially supporting • IBI < 32 = Not supporting Criteria for macroinvertebrate community data were unchanged.
2002	Based on IDEM's adoption of U.S. EPA's integrated reporting format, the category for partially supporting was eliminated for both fish community data and macroinvertebrate community data: • IBI ≥ 32 = Fully supporting • IBI < 32 = Not supporting Criteria for macroinvertebrate community data were unchanged.
2004 to 2008	IDEM completes its first five-year basin monitoring rotation. After reviewing the narrative biological criteria [327 IAC 2-1-3(2)] and water quality standard definition [327 IAC 2-1-9(49)] of a well balanced aquatic community, IDEM determined that IBI values previously considered partially supporting are reflective of poorer conditions and should be classified as not supporting. The resulting criteria are now applied to all basins in Indiana: • IBI ≥ 36 = Fully supporting • IBI < 36 = Not supporting With a more robust set of macroinvertebrate community data, IDEM was also able to calibrate its criteria for this type of data, developing specific criteria applicable to all basins in the state. For samples collected with an artificial substrate sampler: • mIBI ≥ 1.8 = Fully supporting • mIBI < 1.8 = Not supporting For samples collected using kick methods: • mIBI ≥ 2.2 = Fully supporting • mIBI < 2.2 = Not supporting
2010	Criteria for fish community data remain unchanged. IDEM developed a new mIBI using mHAB sampling methods that accounts for all habitat types available at a given site and which is applicable in all basins in the state. All samples are collected using a D-frame net, and mIBI scores range from 12-60: • mIBI ≥ 36 = Fully supporting • mIBI < 36 = Not supporting

CONSOLIDATED LISTING METHODOLOGY

For the development of the 2010 Draft 303(d) List of Impaired Waters, IDEM has followed, to the degree possible, the 305(b) and 303(d) reporting methods outlined in the U.S. EPA's *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* (U.S. EPA, 2005) and the additional guidance provided in the U.S. EPA memorandums *Information Concerning 2010 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions* (U.S. EPA, 2009). The 303(d) list was developed using IDEM's 305(b) Assessment Database (ADB). Interpretation of the data and listing decisions take into account IDEM's assessment methodologies, U.S. EPA's guidance.

Waterbody AU were classified as monitored if surface water quality data used for assessments were not more than five years old or were still considered representative of current conditions. Data from a given monitoring site are considered representative of the waterbody for that distance upstream and downstream in which there are no significant influences to the waterbody that might cause a change in water quality. Using this same rationale, data may also be extrapolated to some distance into tributaries upstream of a given sampling location. Waterbody AU with monitoring site(s) upstream and downstream and those for which reliable assessments can be made based on extrapolation of representative data are classified as monitored. Only monitored waterbodies are considered for 303(d) listing purposes. Any waters identified as "Not Supporting" of one or more designated uses in accordance with the criteria described in previous sections of this methodology are placed on Indiana's 303(d) List of Impaired Waters.

Interpretation of the data through the 305(b) assessment process and the subsequent 303(d) listing decisions are based in large part on U.S. EPA guidance. U.S. EPA's guidance calls for a comprehensive listing of all monitored or assessed waterbodies in the state. Prior to 2006, U.S. EPA required that states place each waterbody into only one category. U.S. EPA now encourages states to place waterbody AU in additional categories as appropriate in order to more clearly illustrate where progress has been made in TMDL development and other restoration efforts. Given this, IDEM places each waterbody into one of five categories of the Consolidated List depending on the degree to which it supports the designated beneficial use in question. Therefore, because IDEM makes use support assessments for three to four of the beneficial uses designated for each waterbody, a single waterbody may appear in one or more categories of the Consolidated List for different uses.

LISTING OF WATERBODY IMPAIRMENTS BY CATEGORY

Category 1 **Attaining the water quality standard for all designated uses and no use is threatened.** Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology and support a determination that all WQS are attained and no designated use is threatened.

Category 2 **Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.** Waters should be listed in this category if there are data and information that meet the requirements of the state's assessment and listing methodology to support a determination that some, but not all, designated uses are attained and none are threatened.

Category 3 **Insufficient data and information to determine if any designated use is attained.** Little or no information is available with which to make an assessment.

Waters should be listed in this category where the data or information to support an attainment determination for any designated use are not available or are not consistent with the requirements of the state's assessment and listing methodology. States should schedule monitoring on a priority basis to obtain data and information necessary to classify these waters as Category 1, Category 2, Category 4, or Category 5.

Category 4 Impaired or threatened for one or more designated uses but does not require the development of a TMDL.

A. A TMDL has been completed that results in attainment of all applicable WQS, and has been approved by U.S. EPA. Monitoring should be scheduled for these waters to verify that the WQS are met when the water quality management actions needed to achieve all TMDLs are implemented.
B. Other pollution control requirements are reasonably expected to result in the attainment of the WQS a reasonable period of time. Consistent with the regulation under 130.7(b)(i),(ii), and (iii), waters should be listed in this subcategory where other pollution control requirements required by local, state, or federal authority are stringent enough to achieve any water quality standard (WQS) applicable to such waters. Monitoring should be scheduled for these waters to verify that the WQS are attained as expected.
C. Impairment is not caused by a pollutant. Waters should be listed in this subcategory if the impairment is not caused by a pollutant but is attributed to other types of pollution for which a total maximum daily load cannot be calculated.

Category 5 The water quality standard is not attained. Waters may be listed in both 5A and 5B depending on the parameters causing the impairment.

A. The waters are impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. Waters should be listed in this category if it is determined in accordance with the state's assessment and listing methodology that a pollutant has caused, is suspected of causing, or is projected to cause impairment. Where more than one pollutant is associated with the impairment of a single AU, the AU will remain in Category 5 until TMDLs for all pollutants have been completed and approved by U.S. EPA.
B. The waterbody AU are impaired due to the presence of mercury or PCBs, or both in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants. This category also composes a portion of the Section 303(d) list of impaired waters, but the state believes that a conventional TMDL is not the appropriate approach. The state will continue to work with the general public and U.S. EPA on actual steps needed ultimately to address these impairments.

Because each situation is unique, resources, and data sets are sometimes limited, the 303(d) listing process may at times require IDEM staff to apply rational professional discretion. Any waterbody AU assessed differently than indicated in the water quality assessment methodology outlined above will be accompanied by written justification, so that stakeholders will understand how each decision was made.

The current 303(d) list includes impairments identified on previous 303(d) lists, which still require TMDL development. For an AU to be listed, it must have been assessed using representative data, and the data must support listing. Any data, both internal or from outside sources, that is used for listing decisions must meet IDEM's quality assurance and quality control (QAQC) requirements as outlined in IDEM's surface water quality monitoring Quality Assurance Project Plan.

DELISTING OF IMPAIRMENTS

The U.S. EPA's new guidance does not change existing rules for listing and delisting. The existing regulations require states, at the request of the U.S. EPA's Regional Administrator, to demonstrate good cause for not including impairments on the 303(d) list that were included on previous 303(d) lists (pursuant to 40 CFR 130.7(b)(6)(iv)). In general IDEM will only consider delisting an AU if one of the following is true:

- New data indicate that WQS are now being met for the AU under consideration. This would typically occur during IDEM's scheduled assessments when reviewing data collected through our 5-year basin rotation.
- The assessment or listing methodology, or both has changed, and the AU under consideration would not be considered impaired under the new methodology.
- An error is discovered in the sampling, testing, or reporting of data that led to an inappropriate listing. IDEM will review previous assessments and 303(d) listings when there is reason to believe that the original assessment was not valid. Reassessment (review of previous assessment or 303(d) listing decisions) typically occurs as a result of ongoing QA/QC of IDEM's Assessment Database (ADB) or through inquiry by IDEM staff or external parties. Under these circumstances, the 305(b)/303(d) coordinator works with the IDEM staff initiating the question or receiving it from the external party to gather the necessary information and consult with other staff as needed to resolve the question. During reassessment, several types of information are considered, including data quality issues, past assessment methodologies, land use data, historical information from the public, etc. Regardless of the situation, no assessment is dismissed as invalid based solely on the age of the data.
- If it is determined that another program, besides the TMDL program, is better suited to address the water quality problem, or the problem is determined not to be caused by a pollutant (see Categories 4B[5] and 4C above).
- A TMDL has been completed, and the waterbody AU is expected to meet WQS after implementation of the TMDL (see Category 4A above).

[5] A decision to list a water in Category 4B using §130.7(b)(1)(i) must be supported by the issuance of technology-based effluent limitations required by Sections 301(b), 306, 307 or other sections of the CWA. A decision to list in Category 4B using §130.7(b)(1)(ii) must be supported by the issuance of more stringent effluent limitations required by federal, state or local authority. EPA expects that the state will provide a rationale for why they believe that these effluent limits will achieve WQS within a reasonable period of time. Placement of waters in Category 4B based on §130.7(b)(iii) must be supported by the existence of "other pollution control requirements (for example, best management practices) required by local, state, or federal authority" that are stringent enough to implement WQS. EPA expects that the state will demonstrate that these control requirements will achieve WQS within a reasonable period of time.

TMDL DEVELOPMENT AND PRIORITIZATON FOR OHIO RIVER IMPAIRMENTS

Because the Ohio River is a boundary between states and US EPA Regions, the development of a TMDL for the river will involve more than one state. To date, no TMDLs have been completed for the reaches of the Ohio River that border Indiana. However, ORSANCO is working with Ohio, West Virginia, Kentucky, Illinois, and Indiana (IDEM) to assist U.S. EPA Region 5 complete a bacteria TMDL for the entire river.

TMDL DEVELOPMENT AND PRIORITIZATION FOR ALL OTHER INDIANA WATERS

IDEM prioritizes impaired waters for TMDL development in order to meet its TMDL goals. IDEM's basin-rotation water quality monitoring schedule continues to be a factor in determining where TMDL development will occur to the extent that it provides data for use in the TMDL. For example, if IDEM is monitoring in a given basin in one year, the data collected will usually be available the following year for incorporation into a TMDL. To take advantage of all available resources for TMDL development, the following additional factors are considered when determining when impairments on the 303(d) list (Category 5) will be scheduled for TMDL development:

- The quantity and age of available data – AU for which the most current and robust data available will receive greater priority than AU for which data are scarce or nonexistent.
- The nature of impairment – The three leading causes of impairment to Indiana's waters are impairments due to the presence of mercury or PCBs, or both in fish tissue, *E. coli*, and impaired biotic communities (IBC). To date, states have received little guidance from U.S. EPA regarding how to develop a TMDL to restore a waterbody with elevated levels of mercury or PCBs, or both in fish tissue. IDEM has placed all fish tissue impairments in a separate category of the list (5B) because it does not believe that, at this point in time, a conventional TMDL is the appropriate approach for addressing these impairments. Until adequate guidance is available, IDEM believes it to be more prudent to focus its limited resources on developing TMDLs on impairments for which appropriate methods have been established.
- Other activities occurring in the watershed which may improve water quality if given sufficient time – TMDL development for impairments to waterbody AU where other interested parties, such as local watershed groups, may be working to alleviate the water quality problem may be delayed to give these other actions time to have a positive impact on the waterbody. If WQS still are not met, then the TMDL process will be initiated.

In keeping with the need to make the best possible use of limited resources, IDEM's primary focus in the short term is on *E. coli*. IDEM has established an effective method for developing *E. coli* TMDLs and will continue to use this method to address the second leading cause of impairment to Indiana's surface waters. IBC, which is the third leading cause of impairment of surface waters is more difficult to address because IBC are actually a symptom of other unidentified stressors in the environment, which may include a combination of pollution, for which no TMDL would be required, and one or more pollutants. IDEM continues to explore different methods of source identification through its second-year studies program and has plans to complete additional TMDLs over the next two years for a number of IBCs and other impairments, including nutrients, sulfates, total dissolved solids, dissolved oxygen, pH, nickel, zinc, and copper.

Waterbodies on the 303(d) list are scheduled to complete the TMDL development process within 15 years. Since the CWA does not clearly define the timeline for TMDL development, U.S. EPA, in response to the Federal Advisory Committee Act (FACA) Committee's recommendations, issued

guidance for states to develop expeditious schedules of not more than eight to 15 years. 40 CFR section 130.7 also dictates that the 303(d) list specifically include the identification of waters targeted for TMDL development in the next two years. This list was submitted to U.S. EPA with Indiana's finalized 303(d) List of Impaired Waters in October, 2010.

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APPENDIX A: COMPARISONS OF WATER QUALITY CRITERIA CONTAINED IN INDIANA'S WATER QUALITY STANDARDS AND ORSANCO'S POLLUTION CONTROL STANDARDS AND OTHER CRITERIA FOR MAKING DESIGNATED USE ASSESSMENTS OF THE OHIO RIVER.

Table A-1: Comparison of criteria used to determine recreational use support.

Indicator	Type of Criterion	ORSANCO's RECR Criterion	Indiana's RECR Criterion	Most Stringent Criterion[1]
E. coli	Geometric Mean	Applicable May-October (Recreational Season); May not exceed 130 cfu/100 mL based on no less than five samples per month	Applicable April-October (Recreational Season); May not exceed 125 cfu/100 mL based on no less than five equally spaced samples over a 30-day period. Must apply the single sample maximum criteria if five equally spaced samples are not available for the calculation of a geometric mean.	Indiana
E. coli	Single Sample Maximum	Applicable May-October (Recreational Season); May not exceed 240 cfu/100 mL in any sample	Applicable April-October (Recreational Season); May not exceed 235 cfu/100 mL in any one sample in a thirty day period **EXCEPT** in cases where there are at least ten samples at a given site, up to 10% may exceed the single sample maximum **IF** *E. coli* exceedances are incidental and attributable solely to *E.coli* resulting fom the discharge of treated wastewater from a wastewater treatment plan as defined in Indiana Code **AND** the geometric mean criteria are met.	Indiana

[1]Although Indiana's *E. coli* numeric criteria are slightly more stringent than ORSANCO's, unlike Indiana's WQS, ORSANCO's criteria do not allow exceptions. ORSANCO's assessment methodology also incorporates analysis of single sample results, which provides a more robust assessment than Indiana's combined criteria and assessment methodology can. Indiana therefore defers to ORSANCO's assessments of recreational use support for the Ohio River. ORSANCO conducts bacterial sampling from May to October, which is one month shorter than the recreational season defined in Indiana's WQS. Given this, data are not available for Indiana's full recreational season.

Table A-2: Comparison of criteria used to determine fish consumption use support.

Indicator	Type/Source of Criterion	ORSANCO Criterion	Indiana Criterion	Most Stringent Criterion
Methylmercury in Fish Tissue (ug/L)	Human Health Criterion for Methylmercury (U.S. EPA, 2001a)	0.3	0.3	Equally Stringent
Total Mercury in Water (ug/L)	Aquatic Life CAC (4-day average) Outside the Mixing Zone (Indiana); Not to exceed (ORSANCO)	0.012	0.012	Equally Stringent
Dioxin (2, 3, 7, 8-TCDD) in Water (ug/L)	CCC Human Health (30-day average) Outside the Mixing Zone (Indiana); CWA Section 304(a) Human Health Criterion for Priority Pollutants (ORSANCO)	0.000000005	0.0000001	ORSANCO
Polychlorinated Biphenyls (PCBs) in Water (ug/L)[1]	CCC Human Health (30-day average) Outside the Mixing Zone (Indiana)/Aquatic Life CAC (4-day average) Outside the Mixing Zone; CWA Section 304(a) Human Health Criterion for Priority Pollutants (ORSANCO)	0.000064[2]	0.00079	ORSANCO

[1] Indiana has two criteria for PCBs which could be used to make fish consumption use assessments because they both address different ways of preventing exposure through consumption of fish, one by preventing bioaccumulation of the contaminant in the fish and the other to protect against exposure through the consumption of contaminated fish. The criterion shown in the table is the CCC Human Health criterion for waters outside the mixing zone. Human health criteria are calculated for and intended to protect from exposure through public drinking water supplies withdrawn from surface waters and nondrinking water exposures such as consumption of fish. Therefore, the human health criteria (both ORSANCO's and Indiana's are appropriate for use in fish consumption assessments. The Aquatic Life CAC of 0.014 ug/L for PCBs could be used in a similar manner as the Aquatic Life CAC for total mercury to prevent bioaccumulation of PCBs in fish. However, the Human Health CCC for PCBs is far more protective and is used instead to make fishable use assessments for the Ohio River. The opposite is true for total mercury, which is why the Aquatic Life CAC of 0.012 ug/L is used instead of the Human Health CCC of 0.15 ug/L.

[2] This criterion applies to total PCBs (e.g. the sum of all congener or all isomer or homolog or Arochlor analyses).

Table A-3: Comparison of metals criteria used to determine aquatic life use support.

Metal	Fraction	Acute or Chronic	ORSANCO's Criterion Concentration (ug/L)	ORSANCO's Dissolved Criterion Conversion Factors	Indiana's Criterion Concentration (ug/L)	Indiana's Dissolved Criterion Conversion Factors	Most Stringent Criterion
Cyanide[1]	Free	Chronic	5.2	NA	5.2	NA	Equally stringent
Mercury[1]	Dissolved (ORSANCO); Total Recoverable (Indiana)	Chronic	0.91	0.85 (dissolved)	0.012 (total recoverable)	NA	Indiana
Arsenic[1]	Dissolved[2]	Chronic	150	1	190	1	ORSANCO
Cadmium	Dissolved[2]	Chronic	$e^{(0.7409(\ln \text{hardness})-4.719)}$	1.101672 - [ln(hardness) * 0.041838]	$e^{(0.7852[\ln (\text{hardness})]-3.490)}$	1.101672 - [(ln(hardness) (0.041838)]	ORSANCO
Chromium III	Dissolved[2]	Chronic	$e^{(0.819(\ln \text{hardness})+0.6848)}$	0.86	$e^{(0.8190[\ln (\text{hardness})]+1.561)}$	0.86	ORSANCO
Copper	Dissolved[2]	Chronic	$e^{(0.8545(\ln \text{hardness})-1.702)}$	0.962	$e^{(0.8545[\ln (\text{hardness})]-1.465)}$	0.96	ORSANCO
Lead	Dissolved[2]	Chronic	$e^{(1.273(\ln \text{hardness})-4.705)}$	1.46203 - [ln(hardness) * 0.145712]	$e^{(1.273[\ln (\text{hardness})]-4.705)}$	1.46203 – [(ln hardness) (0.145712)]	Equally stringent
Nickel	Dissolved[2]	Chronic	$e^{(0.846(\ln \text{hardness})+0.0584)}$	0.997	$e^{(0.846[\ln (\text{hardness})]+1.1645)}$	0.997	ORSANCO
Zinc	Dissolved[2]	Chronic	$e^{(0.8473(\ln \text{hardness})+0.884)}$	0.986	$e^{(0.8473[\ln (\text{hardness})]+0.7614)}$	0.986	Indiana

[1] This criterion is expressed in ORSANCO's Pollution Control Standards as "Not to Exceed" and in Indiana's Water Quality Standards as a 4-day average.

[2] Unless otherwise shown, dissolved metals criteria are calculated as the total recoverable criterion multiplied by the dissolved criterion conversion factor. Assessments are made by comparing dissolved results against the established or calculated criterion.

Table A-4(a): Comparison of sulfate and cyanide criteria used to determine aquatic life use support.

Indicator	Type of Criterion	ORSANCO's ALUS Criterion	Indiana's ALUS Criterion	Most Stringent Criterion
Cyanide[1] (ug/L)	Chronic	5.2	5.2	Equally stringent
Chloride[2] mg/L)	Chronic	No criterion	230	Indiana
Sulfate[3] (mg/L): Hardness (mg/L as CaCO3) > or = 100 mg/L but < or = 500 mg/L **AND** Chloride (mg/L) > or = 5 mg/L but < 25 mg/L	Not to Exceed	No criterion	[-7.478+(5.79*hardness) + (54.163*chloride)] * 0.65	Indiana
Sulfate[3] (mg/L): Hardness (mg/L as CaCO3) > or = 100 mg/L but < or = 500 mg/L **AND** Chloride (mg/L) > or = 25 mg/L but < or = 500 mg/L	Not to Exceed	No criterion	[1.276+(5.508*hardness) - (1.457*chloride)] * 0.65	Indiana
Sulfate[3] (mg/L): Hardness (mg/L as CaCO3) < 100 mg/L **AND** Chloride (mg/L) < or = 500 mg/L	Not to Exceed	No criterion	500	Indiana
Sulfate[3] (mg/L): Hardness (mg/L as CaCO3) > 500 mg/L **AND** Chloride (mg/L) > or = 5 mg/L but < 25 mg/L	Not to Exceed	No criterion	[57.478+(5.79*500) + (54.163*chloride)] * 0.65	Indiana
Sulfate[3] (mg/L): Hardness (mg/L as CaCO3) > 500 mg/L **AND** Chloride (mg/L) > or = 25 mg/L but < or = 500 mg/L	Not to Exceed	No criterion	[1.276+(5.508*500) - (1.457*chloride)] * 0.65	Indiana

[1] This criterion is expressed in ORSANCO's Pollution Control Standards as "Not to Exceed" and in Indiana's Water Quality Standards as a 4-day average.

[2] ORSANCO's Pollution Control Standards do not contain a chloride criterion for the protection of aquatic life. Therefore, IDEM uses the data collected by ORSANCO for the purposes of making its aquatic life use assessments for the Ohio River.

[3] Indiana's criterion for sulfate is a calculated criterion which requires both pH and hardness values and is rounded to nearest whole number for the purposes of assessment. ORSANCO's Pollution Control Standards do not contain a sulfate criterion for the protection of aquatic life. Therefore, IDEM uses the data collected by ORSANCO to calculate the applicable criteria for the purposes of making its aquatic life use assessments for the Ohio River.

Table A-5: Comparison of ammonia, dissolved oxygen, pH and temperature criteria used to determine aquatic life use support.

Indicator	Type of Criterion	ORSANCO's ALUS Criterion	Indiana's ALUS Criterion	Most Stringent Criterion
Ammonia (mg/L) applicable March 1 to October 31	Not to Exceed	$[((0.0577/(1+10^{(7.688-pH)}))) + (2.487/(1-10^{(pH-7.688)}))]$ * Minimum of (2.85 or $(1.45*10^{0.028*(25-T)})$) Where: T = Temperature, °C Note: For the above equation, multiply the parenthetical equation by 2.85 when T < or = 14.51ºC. When T > 14.51ºC, multiply the parenthetical equation by $(1.45 * 10^{(0.028*(25-T)})$.	$[((0.0577/(1+10^{(7.688-pH)}))) + (2.487/(1-10^{(pH-7.688)}))]$ * $(1.45*10^{0.028*(25-(MAX [T OR 7]))})$ Where: T = Temperature, °C Note: For the above equation, the last term should be $10^{(0.028*(25-T))}$ for all T > 7ºC. When T = 7ºC or less, the last term in the equation should be $10^{(0.028*(25-7))}$ or $10^{(0.504)}$	Equally stringent
Ammonia (mg/L) applicable November 1 to last day of February	Not to Exceed	$[((0.0577/(1+10^{(7.688-pH)}))) + (2.487/(1-10^{(pH-7.688)}))]$ * $(1.45*10^{0.028 * (25-(MAX [T OR 7]))})$ Where: T = Temperature, °C Note: For the above equation, the last term should be 10(0.028*(25-T)) for all T > 7ºC. When T = 7ºC or less, the last term in the equation should be 10(0.028*(25-7)) or 10(0.504)	Same criteria year round	Equally stringent
Dissolved Oxygen (mg/L) applicable April 15 to June 15	Not to Exceed	Minimum concentration at least 5 at all times	Avg concentration at least 5.0 per calendar day; minimum concentration not < 4 at any time	ORSANCO
Dissolved Oxygen (mg/L) applicable June 16 to April 14	Not to Exceed	Avg concentration at least 5.0 per calendar day; minimum concentration not <4	Avg concentration at least 5.0 per calendar day; minimum concentration not <4 at any time	Equally stringent
pH (standard units)	Not to Exceed	No value <6.0 nor >9.0	No value <6.0 nor >9.0	Equally stringent
Temperature (expressed in degrees C and F)	Not to exceed	Allowable values expressed as Period Averages and Maximum Temperatures	Allowable values expressed as Maximum Temperatures	ORSANCO[4]

[4] Both ORSANCO's Pollution Control Standards and Indiana's Water Quality Standards articulate maximum allowable temperatures. ORSANCO's standards also include allowable period average temperatures, which are more stringent than the maximum allowable temperatures in either set of standards.

APPENDIX B: DERIVATION OF CRITERIA VALUES FOR CONCENTRATIONS OF MERCURY AND PCBS IN FISH TISSUE

U.S. EPA stipulates that the risk assessment parameters used to categorize fish tissue contaminant data must be at least as protective as those used in the WQS-based fish concentrations. The equation for calculating a fish tissue criterion for PCBs utilizes the guidance provided by U.S. EPA for calculating screening values for target analytes (http://www.epa.gov/waterscience/fishadvice/volume1/v1ch5.pdf). EPA's Office of Water recommends the use of this calculation method because it is the basis for developing current water quality criteria for the protection of human health. The general equation used for calculating Screening Values (SVs) for carcinogens in fish tissue is derived from this guidance and is as follows:

$$SV_c = [(RL / CSF) \bullet BW] / CR \qquad \text{Equation 1}$$

where:

SV_c = Screening value for a carcinogen (mg/kg; ppm)
RL = Maximum acceptable risk level (dimensionless)
CSF = Oral cancer slope factor $(mg/kg\text{-}d)^{-1}$
BW = Mean body weight of the general population (kg)
CR = Mean daily consumption rate of species of interest (kg/d)

In determining a screening value or fish tissue criterion for PCBs, the same assumptions and parameters used for calculating human health water quality criteria were applied. These parameters include a BW of 70 kg, CSF (of 2.0 $(mg/kg\text{-}d)^{-1}$, RL of 10^{-5}, and CR of 17.5 (g/d).
The general equation for calculating a fish tissue screening value for PCBs is:

$$Fish\,Tissue\,ScreeningValue\,(mg/kg) = \frac{\left[\frac{Cancer\,Risk\,Level}{q1^{*}\left((mg/kg/d)^{-1}\right)}\right] \times Body\,Weight\,(kg)}{Fish\,Consumption\,(kg/d)} \qquad \text{Equation 2}$$

Therefore,
Cancer risk level (the RL value from equation 1) = 10^{-5}
$q1$ (the CSF from equation 1) = of 2.0 $(mg/kg\text{-}d)^{-1}$
BW (same in both equations) = 70 kg
Fish Consumption (CR in equation 1) = 17.5 (g/d) or 0.0175 (kg/d)

$$PCB\ \ Fish\,Tissue\,ScreeningValue\,(mg/kg) = \frac{\left[\frac{1E-05}{2.0\,(mg/kg/d)^{-1}}\right] \times 70\,(kg)}{0.0175\,(kg/d)} = 0.02\,(mg/kg)$$

A tissue-based criterion eliminates the need for a bioaccumulation factor in the criterion calculation while PCB exposure from drinking water is negligible (http://www.great-lakes.net/humanhealth/lake/superior.html).